



THE

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY

OF ENGLAND.

VOLUME THE THIRD.

1842.

PRACTICE WITH SCIENCE.

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1842

LONDON:

JOHN MURRAY, ALBEMARLE STREET.

MDCCCXLII.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH, IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

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ERRATA.

PART I.

In Mr. Murchison's paper, p. 130, line 21, *for* "hectares" *read* "hectolitres."

PARTS II.—III.

In Mr. Pusey's paper, p. 185, line 10, *for* "36s." *read* "54s."

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ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*On the Improvements which have taken place in West Norfolk.*

By the Right Hon. EARL SPENCER.

EVERY one connected with agriculture in this country, and probably in Europe and America, has heard of the improvements in the agriculture of West Norfolk, brought about by the exertions, liberality, and example of the Earl of Leicester. It is known that it is his boast, as it well may be, that he has converted West Norfolk from a rye-growing to a wheat-growing district. That this statement is well-founded, is proved by the fact that the small ports of Blakeney, Cley, Wells, Burnham, and Brancaster, which, when Lord Leicester came into possession of his estate, and for many years afterwards, constantly imported a large quantity of wheat, have become exporting ports, and that now for many years a great deal more wheat has been exported from them than has been imported into them, and this has occurred notwithstanding the great increase of population which has taken place, and consequently the great increase in the consumption of wheat which must have occurred in the district, which those ports used formerly to supply.

These are striking facts: they cannot be denied, nor can they be accounted for in any way but by the improvement in the cultivation of the soil which has taken place. They are not only interesting to those who are practically engaged in agricultural pursuits, but they are also interesting to the philosopher, because they prove, that, although the general principle must be admitted to be true, that population will press upon the means of subsistence, yet to a certain point at least the skill and industry of man may counteract this tendency, and supply a greatly increased population, not only with the same, but with a much better description of food from the same district.

It has appeared to me, that it would be interesting to our Society, not only to state these results, but to endeavour to point out the means by which they have been produced; and with this view I have made the best inquiries I could from Lord Leicester, the only person now living who is able to recollect the former state of this district, and to tell the means by which it has been improved into its present flourishing condition.

Lord Leicester came into possession of his estate in the year 1776. At this time the whole district round Holkham was unenclosed, and the cultivation was of the most miserable character; the course of cropping, as long as the land would produce anything, was three white crops in succession, and then broadcast turnips; no manure was purchased, and very little, and that of no value, was produced on the farm. The sheep were of the old Norfolk breed, and, with the exception of a few milch cows, there were no cattle kept upon any of the farms.

It happened that the lease of a large part of the land, which now forms Holkham Park, was within two years of its expiration. In the lease previous to the one then current, this land had been let at 1*s.* 6*d.* an acre; in the then current lease it had been raised to 3*s.*; Lord Leicester offered to the tenant to renew it at 5*s.*, but Mr. Brett, the tenant, who deserves to have his name recorded for the great good he unintentionally did to the country, refused to give so much for the land, upon which Lord Leicester determined to take it into his own hands. Thus the real origin of the great improvement of this district was, that Mr. Brett refused to give 5*s.* an acre for land, which now, under an improved system of cultivation, usually produces nearly four quarters of wheat per acre. For nothing would have been much more improbable than that Lord Leicester, then an extremely young man, fond of and excelling in field-sports, with a princely fortune, should have applied himself to the detailed management of a farm, had he not been compelled to take this tract of land into his own hands by the refusal of Mr. Brett to accept the terms which were offered to him. But having taken it, he found, as every man who will apply himself to agriculture will, the high interest of the pursuit, his taste was formed, the habits of his life accommodated themselves to it, and applying the whole energy of his mind to the collection and dissemination of all the knowledge which he could derive from practical and scientific farmers, he has effected the great improvements which, while they have been a source of continued happiness to himself, have produced the most incalculable benefits to the country. If, on the other hand, Mr. Brett had accepted the terms offered to him, Lord Leicester would have granted him a lease for twenty-one years, and for that long period of time, and probably much longer, no improvement

would have taken place; West Norfolk would still have been considered a district in which wheat could not be grown, and, what would have been a still greater misfortune, Lord Leicester might never have turned his attention to agricultural pursuits.

The lease having thus expired in 1778, Lord Leicester commenced farming. He was, however, necessarily ignorant of any of the knowledge necessary to conduct the management of a farm. But he took the only means which could give him the information he required; he began at once to collect around him practical men, and invited to his house annually a party of farmers, at first only from the neighbouring districts; at these meetings agricultural topics were discussed, Lord Leicester's farm was examined, and his management of it either criticised or approved, and by thus receiving information, and again communicating it to others, not only did Lord Leicester himself arrive at the knowledge of agricultural management, but the practical men who attended these meetings left them better informed than when they came. In the course of time, friends of Lord Leicester came from a distance to attend them, and thus ultimately this small beginning expanded into the far-famed Holkham sheep-shearing.

As one of the first consequences of these discussions, he adopted a somewhat improved course of cropping; instead of growing three white crops in succession, he only grew two, and kept the land in pasture for two years in every course. This change appears gradually to have improved the land, and I find from the old accounts of the farm that wheat was first sown upon it in 1787. This improved course of cropping, though quite essential, was not of itself sufficient to enable him to grow wheat. The land, naturally very weak, was still more impoverished by the exhausting treatment it had received. In order to get it into better condition, it was absolutely necessary greatly to increase the number of live stock which had hitherto been kept upon it; but the production of food for them was so small, that it was impossible at first to adopt this mode of improvement to any great degree. The first thing to be done was the purchase of manure. Lord Leicester was induced to try rape-cake as a top dressing, and it answered admirably. Another much more effective source of fertility was adopted, and to a much greater degree than it hitherto had been. The surface-soil of the whole district is a very light sand, but nearly throughout it there is a stratum of rich marl at various depths underneath. Pits were opened, and the marl dug out and laid upon the surface. This not only increased its fertility, but gave to the soil the solidity which is essential to the growth of wheat. By these means clover and other artificial grasses were raised, and the power of keeping more live stock was obtained.

As has been said, the only live stock then kept were the

Norfolk sheep, there were no cattle. Lord Leicester made no change in the sort of sheep, and adopted Mr. Bakewell's Leicester breed of long-horned cattle. This, indeed, was the only breed of cattle to the improvement of which at that time any attention had been paid, and a young man applying himself to improved agriculture would naturally have been led to select them. When, some time afterwards, he found that the Norfolk sheep were a very unprofitable sort, the same reasons induced him to try the new Leicester breed, a variety of sheep probably as ill calculated to succeed on such a soil as the one he occupied as any breed which he could have selected. He at last found that the best sort of sheep he could adopt were the South-downs. In this, however, as in every other of his farming experiments, Lord Leicester acted with great caution, and did not make the changes which he did make till thoroughly convinced by practical experience that they would answer. Accordingly, for several years he had upon his farm at the same time Norfolk sheep, new Leicesters, and South-downs: he also tried the Merinos, but he did not persevere long with them. I find that so late as the sheep-shearing of 1812 there were still at Holkham both Norfolk and Leicester sheep. Since that time South-downs have been the only sort which he has kept.

With respect to cattle he persevered with the Leicester long-horned breed for many years; but somewhere towards the close of the last century, Francis Duke of Bedford, with whom he lived on terms of the greatest intimacy, being aware that he was inclined to try the Devonshire cattle, in consequence of the success of a small experiment which he had made in feeding some Devonshire oxen bought from Lord Somerville, bought at the late Lord Ossory's sale a Devonshire bull and some heifers without having had any commission from Lord Leicester, and sent them to Holkham. Upon trial this breed proved to be by far the best breed that could be adopted in such a soil as that of Holkham. Lord Leicester, therefore, gradually replaced the long-horned by increasing his stock of Devonshire cows, but, as in the case of the sheep, some of the long-horned cattle were still to be seen at Holkham as late as 1812: from that time the only cattle which he has bred have been Devons, and the only sheep South-downs. These latter, however, he has of late years crossed with the Hampshire Down sheep, and he considers that this cross has been very successful, by giving greater strength to the constitution of the sheep, by increasing the value of the wool, and by giving a larger proportion of lean meat in the carcasses.

It is not, however, to cattle and sheep only that Lord Leicester has turned his attention: a large portion of the manure produced upon his farm is owing to the number of pigs which he kept.

The Suffolk breed of pigs has always been one of the most valuable in the kingdom, but Lord Leicester has found that, by crossing them with the Neapolitan breed, a much more profitable sort is produced. The pure Neapolitan pigs, though their meat is superior to that of any English pig, are such bad breeders, that they are not advantageous to a farmer, but when crossed with the Suffolk their constitution and breeding qualities are greatly improved, and the cross-breed continues to possess the extraordinary aptitude to feed of the Neapolitan without the weakness of their constitution.

Having thus, by keeping animals of a thrifty and profitable sort, increased greatly the number of his live stock, and by the purchase of rape-cake and the application of marl, in addition to the increased quantity of manure which his live stock produced, improved the fertility of the land, he overcame the difficulty of growing wheat, and he adopted the present Norfolk course of husbandry. The farm at Holkham assumed the appearance of fertility which it has since ever held, and attracted the attention of every one at all interested in the improvement of agriculture. The stock upon this farm, and still more the annual exhibitions of the sheep-shearing proved the great superiority of the South-down over the Norfolk breed of sheep, the latter were abandoned rapidly by the neighbouring farmers, and now in the whole tract of country between Lynn and Holkham such an animal as a Norfolk sheep is not to be seen. The Norfolks have been entirely superseded by the South-downs. Of late years indeed it has become very much the custom both with the farmers generally and also with Lord Leicester himself to put a portion of their South-down ewes to a long-woolled ram, the produce from this cross having proved extremely profitable, but still in all cases the store flock continues to be of the South-down breed. With respect to cattle the example of Lord Leicester has not been so universally followed. The polled Suffolk or Norfolk breed still hold their ground. But though his example in keeping a breeding herd of Devon cattle has been followed only to a limited extent, yet the more important object of carrying a large quantity of stock upon their farms is universally attended to by the Norfolk farmers. The nature of the soil and the scarcity of old pasture is such, that no improvement can be made in cattle by summer-grazing, but all the farm-yards are well stocked during the winter. By this system a large quantity of valuable manure is produced, and the occupiers of this light and weak soil are enabled to cultivate it to advantage. A very small proportion, however, of this stock is bred in Norfolk.

There is scarcely any situation where it would be advantageous to a farmer to breed all the cattle which he fattens, although I

am confident, from practical experience, that it would be advantageous in the best grazing districts to breed a considerably larger proportion than is now done. But in Norfolk, if any large proportion was bred, much of the advantage of carrying a numerous herd of cattle during the winter would be lost. It is perfectly well known that the more nutritious the food is on which cattle are fed, the better is the manure produced: it is therefore of great importance that the number of cattle preparing for the market should bear a large proportion to that of those kept in a store and growing state. It is, therefore, in a soil like that of Norfolk of peculiar importance that much the greater number of the cattle on the farm should only remain on it while they are feeding on the most nutritious food. No difficulty is found in effecting this object; for this district, on which at the commencement of Lord Leicester's career scarcely a head of cattle could be found, has now become the centre of attraction for drovers from every part of the United Kingdom. Devonshire, Scotch, Lincolnshire, and I believe even Irish cattle crowd the fairs throughout the county of Norfolk, and most certainly Norfolk now supplies more than its full share of the beef consumed in the metropolis.

This is the present improved state at which Norfolk has arrived; but in order to trace some of the other main causes of this improvement, it is necessary to go back to the latter end of the last century.

When Lord Leicester had proved by his own practice that wheat might be profitably grown, he endeavoured to persuade the neighbouring farmers to follow his example, but it was nine years before any of them did so: at last the late Mr. Overman, whose skill and ability are well known, made the attempt with perfect success, and from that time the old system fell into disrepute, and the present Norfolk agriculture gradually replaced it.

But any attempt to grow wheat would have been an entire failure as long as the farmers persevered in growing three crops of white grain in succession. The land had been usually let on leases of twenty-one years, the occupying tenantry consequently had full security that they themselves would reap the benefit to be derived from any outlay of capital which they made, or any improvement in agriculture which they introduced; but they were so ignorant of their true interests, that they would not forego the apparent immediate profit of growing corn as long as the land would produce it, although it is perfectly clear that, taking the whole period of their leases into consideration, they were enormous losers by pursuing this course. The leases contained no covenants, and the tenants were at perfect liberty to cultivate their land in any way they thought proper. Lord Leicester, however, having proved by his own experience, and having also

been convinced by the information which he had received from the best practical farmers with whom he was in communication, that a better course of cropping would be greatly to the benefit of the occupying tenant, while it would permanently improve the value of his estate, determined to introduce covenants as to the mode of cultivation into all the leases which he granted. Although in the first instance the covenant only prevented the tenant from growing more than two crops of white grain in succession, yet so great was the ignorance of the farmers, that he met with great difficulty in enforcing even this very modified improvement of the old system.

At last, however, he succeeded. The effect even of this alteration was such, that it proved how disadvantageous to all parties the old system had been; and upon the late Mr. Overman taking a farm of Lord Leicester, he was allowed to draw the covenants of the lease himself. He then inserted the modern improved course of cropping well known as that best adapted to light turnip lands. This lease has been the model on which Lord Leicester's leases have since been drawn, making of course any changes which the peculiar nature of each farm may require. The tenants make no difficulty now about agreeing to adopt the covenants inserted in their leases. The able and skilful farmers whom Lord Leicester has been enabled to collect around him know full well that the course of husbandry enforced by the covenants in their leases, while it is the most advantageous for the improvement of the property of their landlord, is the most profitable for themselves.

I have thus, in an imperfect and superficial manner, stated the course of the improvements which have taken place in West Norfolk. The results are, as I stated in the beginning of this Paper, most interesting and important; the means by which they were brought about very simple and plain, and at first sight apparently inadequate to have produced such effects. As the first of these means, I would put the circumstance of a man in Lord Leicester's station applying himself practically to agriculture, and giving an example by his own practice of what might be effected by the skilful application of resources within the reach of all farmers of ordinary capital. But this example would have had but small effect had it not been for the periodical assemblage of men of intelligence, of practical experience, and of enlightened views, to compare the results of their various systems, to discuss their respective merits, and to criticise their respective defects. This assemblage took place at the Holkham sheep-shearing: Lord Leicester was there ready to try any experiments the probable result of which was likely to be advantageous; he was ready to listen to any suggestions, and to report upon the results at some

subsequent meeting. This liberality, not only in the prizes he offered, but in the magnificent hospitality of these meetings, congregated men from all parts of the civilised world. None but agricultural subjects were discussed: on these the most conflicting opinions were freely given, and as freely canvassed, but everything political was excluded; and thus, although the political opinions of Lord Leicester and of most of his personal friends were not only very decided, but for a great period, and that the most brilliant era of the Holkham meetings, unpopular with the great majority of those connected with the landed interest, yet men of every shade of political opinion were heartily welcome, and confident that, although they might hear some favourite theory of farming ridiculed, they never would find anything hurtful to their political feelings advanced. The sheep-shearing of 1822, indeed, was an exception; political topics were then introduced—it was a bad omen. This sheep-shearing was the last. By means of these discussions the correct theory of agriculture was improved and made known: by theory I mean, what it always should mean, the combination of the results of the best practice in various circumstances; not the fanciful schemes of clever but unpractised projectors, well informed perhaps on other subjects, but deriving the data from which they deduce their plans from the speculations of their own minds, and not from the results of practical experiments. But though the theory was thus made known, its practical effect would have been little upon the improvement of West Norfolk had it not been proved to be right by the experience of men engaged in the cultivation of the district itself.

This was effected by the well-considered covenants introduced by Lord Leicester into his leases. Long leases are advantageous if properly regulated; they give the tenant a security, which he cannot otherwise obtain, that he will reap the benefit of any outlay of capital which he may make upon his farm: but long leases existed in West Norfolk when its agriculture was in the wretched state which I have described. A prejudiced or an ignorant occupier will gain nothing by having a lease; and an unprincipled one, though sufficiently skilful, may leave his land so deteriorated in value, by an exhausting system, at the end of his lease, that it will be without value to his landlord, and unproductive of any benefit to the country, for years after the lease has expired. For this reason it is that the combination of judicious covenants with his long leases has enabled Lord Leicester to effect such great improvement not only on his own estate, but, by the example thus set, to the whole district in which he resides.

Covenants, skilfully drawn, while they secure the landlord, do not interfere with the husbandry of a good farmer, and are

not at all detrimental to him, but they are advantageous to a bad one.

When we look at the results to which I am calling the attention of our Society, what an example do they hold out to all men of landed property, but more especially to young men! We see what one man's exertions can do—we see by beginning in early life to apply himself to agricultural pursuits what immense improvement Lord Leicester has lived to see effected in his estate—what benefit he has conferred upon his country, and what an interesting pursuit he has secured to himself. This he has done without debarring himself at all from the more exciting pursuits of an English country gentleman: during a great part of this period, while he was effecting this great good, he kept a pack of fox-hounds; during the whole of it he has been distinguished for his success as a sportsman in shooting.

He was undoubtedly the original and greatest cause of these beneficial results; his energy, his perseverance, and his liberality were the great moving powers by which the improvements were pressed forward: but one of the means, and that one of the most important, which enabled him to effect what he wished, was the annual sheep-shearing. It is satisfactory to feel that our Society, having the same object of improving the agriculture of the country in view, has adopted the same means, by our annual country meetings, of effecting it. Our power of collecting and disseminating information must be vastly greater than that of any individual; and, seeing the successful results which I have described, I hope and trust we may look forward to producing effects in the highest degree beneficial to the country.

II.—*On the Advantage of Testing the Draught of Ploughs.* By HENRY J. HANNAM.

To Ph. Pusey, Esq., M.P.

DEAR SIR,—You and Mr. Handley have fully made known to the Society the use and value of the dynamometer in the draught of ploughs, and have furnished valuable data for the future guidance of the agricultural community. What chiefly remains to be done is to apply similar experiments to individual cases, that each farmer may make himself acquainted with the degree of power required to work his implements; and whether others are to be found that will work with less strength, and equally answer his purpose.

Your “Inquiry on Draught in Ploughing,” in vol. i. part iii.,

has shown us that great differences do exist in ploughs, and proves that a great portion of the kingdom are, in the important operation of ploughing, needlessly expending a large amount of labour.

A spirit of improvement has existed for some years, and the exertions of plough-makers in many parts of the country have furnished the farmers with implements greatly improved in draught, working powers, and economy in wear. The principal object that now claims the zealous and diligent pursuit of both parties, is lightness of draught, for the important purpose of economizing horse-labour. As a first step to this desirable attainment, no better course, I think, can be pursued than endeavouring to ascertain in every district, by means of the dynamometer or draught-gauge, the lightest plough suited to soil and circumstances, and improving that to the greatest degree. No agricultural association or farmers' club should be without one of these instruments. Neighbours should subscribe to possess one in common; and a farmer or country resident will do a kindness to his friends and neighbours by inviting them with their ploughs to a trial of their respective merits in draught as well as in other properties.

It was a desire to satisfy my neighbours and myself of the great disparity in point of draught existing among the various ploughs used in this district, that led to the experiment of which you have requested me to send you the result; and with this I will combine others that I have made on my farm both before and since, and also one in Kent connected with a meeting of the Isle of Thanet Association.

I shall be glad if others be induced to make and register similar and more complete trials in their own neighbourhoods.

The draught-gauge, to a certain extent, is as essential to the farmer as common weights and measures. To work an unnecessarily heavy-drawing plough is like selling corn by a larger bushel than the standard. So many stones' draught gained in ploughing a given piece of ground are in fact a saving of so much hay and corn. In short, to pass over intermediate calculations, a stone marked on the face of the dynamometer should be considered to represent so many pounds, shillings, or pence. It might not be difficult to give an idea of what one of these stones in draught is worth in horse-keep; and if I have time before closing this paper, I will enter into the calculation; of course considering, along with mere draught, the relative cost also of time and speed.

About fifteen years ago, in accordance with a movement which pretty generally took place in this part of Oxon and Berks, I relinquished the old wooden plough, and adopted the lightest plough then manufactured by Messrs. Perry and Barrett of Reading, and was able to work it with a pair of horses. I have

never since used any other, till last summer, when they sent me a plough of a new make, which they considered of lighter draught.

I could never perceive that I should be a gainer by exchanging this Reading L 2, which I had used so long, (a one-wheel plough with cast-iron body and wooden beam and handles,) for any other I saw at work: its performance, I thought, was seldom exceeded, and my men had little difficulty in maintaining a more than respectable position at the ploughing-matches; and no other I could so readily work with a pair of horses. I had rather a fancy for the Scotch plough, admiring on a neighbouring farm its apparent facility in cleaving and turning off the furrow; but I always thought I had an advantage in the wheel, which secured me a regular depth, and an even-shaped furrow: however, I did not perceive that this wheel really gave my horses an easier draught. I found this L 2 *at home* in every species of work. In drilling turnips it laid a neater and more level ridge (27-inch) than my neighbour's Scotch plough. It was also applicable as a one-horse implement, and I used it extensively in ploughing between ridges, stirring fallows, for the barley-seed furrow, &c., and latterly in forming turnip ridges, instead of the double ridging plough. Nevertheless, in many respects there was room in it for improvement.

Previously to the Liverpool meeting, Messrs. Barrett and Exall sent me their new plough marked D P, to compare in draught with their L 2. I made several trials with them both, and on every occasion found the draught of D P full 2 stones the lighter.

Experiment I.—At this time (early in last July) I collected a few of my neighbours' ploughs. First came the now old-fashioned wooden one-wheel plough, which I relinquished some years ago, and which has now ceased to appear upon almost all the considerable farms except the most clayey. It is still occasionally used by my next neighbour. To the village carpenter and blacksmith, with its friction parts of wood and its wrought-iron share, it has been a profitable implement; but neither in draught, as will be seen, any more than in repairs, can it have been very economical to the farmer. The Watlington plough followed, which, within a considerable circuit of the place in Oxfordshire from which it takes its name, has superseded the above wooden plough, and which is formed, like almost all the improved ploughs in the south of England, with cast-iron body and share attached to a wooden beam and handles. This has nothing very promising in its appearance, though it is a favourite in its district. Lastly came four varieties of Messrs. Barrett's ploughs, which are much used in these and the adjoining counties. Of these were the L 2 and the new make D P, and two, a single and a double-wheel, both marked No. 8, but not having their own mould-boards, as I have

since discovered. I have, however, to include a double plough of Messrs. Barrett's that was on its way to Liverpool, and may be described as a double D P.

The whole were tried on a light gravelly loam, moist from recent showers, from which a crop of *Trifolium incarnatum* had been mowed. One horse only, for reasons which I will explain when I come to the question of single-horse ploughing, was attached to each, except the double plough; and the following statement is the result, in a furrow 8 in. wide by 5 in. deep:—

Drawn by One Horse.

	Stones.
1. Old Oxfordshire, one wheel	20
2. New ditto, Watlington	18
3. Barrett's No. 8 two-wheel, with Ransome's mould-board 132 with ground-wrest	17½
4. Barrett's No. 8 one-wheel, with Brightwell mould-board and ground-wrest	16
5. Barrett's L 2, one-wheel	14
6. Barrett's new plough D P, one wheel	11

Drawn by a Pair.

7. D P	12
8. Barrett's new double plough	24

Thus it will be seen that by my original transition from the wooden plough at 20 stones to the L 2 at 14, I gained 6 stones, equal nearly to 1 horse in 3; and thus showing that my two-horse teams had been working no harder than my three horses had originally. Next to this conviction, this experiment proved to me that I had made a valuable discovery—a still lighter plough—lighter than L 2, I had been so long using. I first had the satisfaction of confirming that I had for some years been undoubtedly saving 30 per cent. in ploughing, and now discover that I may again make a considerable saving by abandoning the L 2, and henceforth adopting the D P; and of course I determined on so doing, should I on trial find the latter equal in other qualities to the former. I have so tried it, and have found it in general work a superior plough; and I am only waiting some further improvements Messrs. Barrett have undertaken in it, to restock myself entirely with it. But I do not hesitate to say that, if I should have the good fortune to meet with a lighter in draught (sufficiently light to amount to a saving, and with qualities equal), this also must share the fate of its two predecessors.

It may be worth while to consider what number of stones gained in draught would justify us in abandoning an old plough. If the power of one horse be put at 10 stones, one stone saved in pair-horse ploughing will be 5 per cent. on each horse. And this 5 per cent. I should consider myself at liberty to set down

as a saving to that amount in horse-keep. Where the ploughing can be brought within the power of one horse this saving is doubled; and in four-horse work the proportion of course is reduced to $2\frac{1}{2}$ per cent. This will serve to give some idea of the saving effected by any amount of gain in the draught of ploughs; but as I must proceed with my observations on our experiment, I will reserve calculations to a future time.

The intermediate draughts (2, 3, and 4 in the table) will speak for themselves. I will only express my strong doubts of the actual advantage derived from any shapes that cause such an excess of draught. This excess is occasioned in a considerable degree, as I imagine, by the full breast, which presents a greater resistance; and it is used because in adhesive soils in a certain state they accumulate the mould upon them in a less degree. It is yet to be decided whether this advantage is not obtained at too great a sacrifice of horse-strength.

I tried D P again with a pair of horses for the purpose both of comparing it with the double plough, and seeing what the addition of the double whipper-tackle would have upon the draught; and I found this latter caused an increase of a stone—and thus much of saving in favour of one horse in a plough.

There could not be a more conclusive trial of the respective draughts of double and single ploughs than was made in the above experiment. Messrs. Barrett's very complete double plough is simply two D P's combined, the mould-boards, &c. being the same casting. The very equal result shows in the first place its careful construction; and the uniform working of both ploughs, whether single or combined, which was exhibited in other trials as well as the above, was a satisfactory proof of the correctness of the trials and of the soundness of the method of test. And again, this uniform result, namely, that the draught of the double was found almost always twice that of the single, supplies data on which to found a correct estimate of the merits and value of a double plough.

The result of this and other little trials left no doubt which was the fitter plough for competition at the Annual Meeting at Liverpool. D P was there entered for trial as a one-horse plough, and, by the prize it obtained, was adjudged to be the lightest in draught of all the ploughs there brought forward.

During the winter it was constantly at work with L 2; and when I occasionally tested it with the draught-gauge, I always found it, as I had done before, more than 2 stones lighter. And on one occasion, when they were ploughing a good gravelly loam to the depth of 7 inches, I found L 2 working at a draught of 22, and D P at 18 stones.

Experiment II.—The trial you heard of and requested for the

Journal arose from a neighbour begging to have his wooden plough, of which he had a very good opinion, compared with my D P; when I took the opportunity of collecting a few more, and inviting my neighbours to the inspection; and with their assistance I was enabled to bring forward in this experiment a few of the ploughs that have engaged the attention of the Society: for example—Ransome's N L 7, the lightest in Mr. Handley's experiments, and a prize-plough at Liverpool; Hart's improved Berkshire; the Scotch iron swing-plough; Barrett's D P, before described, and the old Oxfordshire—which, like the old Berks, and the original plough in many districts, forms a useful addition to an experiment to show the advance new ploughs have made. But I will describe the whole in the order in which they took up a position by the draught-gauge.

They consisted of:—

1. The before-mentioned wooden plough from Cuddesden, which proved to be the old one-wheel of the county.

2. The old Burcott plough, which was tried in a former experiment. Both these were exactly of the same description, entirely of wood, and are of the same family as the Berkshire.

3. An iron Scotch (Roxburghshire) plough from the late Mr. Jonathan Peel's farm near Abingdon.

4. Barrett's No. 8 two-wheel on galleys, having on a Ransome mould-board marked 132, with a ground-wrest attached, and of general proportions stout enough for any work.

5. Barrett's No. 8 one-wheel, fitted with a Brightwell (village in the neighbourhood) mould-board, with ground-wrest—a plough somewhat like, but much stouter than my L 2.

6. A Watlington one-wheel plough, which I have before described, and which has very strongly the common characteristics of the improved ploughs of these counties—a full-breasted mould-board, and a detached under mould-board called a ground-wrest, which sweeps out the furrow and forms a support for the plough at the heel.

7. Hart's one-wheel. I had my doubts whether this was precisely the plough described in your "Inquiry" in vol. i. part iii. of the Journal, fancying it was a larger size, and adapted for heavy work, but I have since ascertained it to be the same.

8. Ransome N L 7, called in your paper the Rutland, and known as the lightest in Mr. Handley's experiments, and which is an excellent plough I should imagine in every kind of soil. Its heavy proportions and appearance are counteracted by its perfectly-formed mould-board, which enables it, where the soil is not in too adhesive a state, to take up a position among the lightest ploughs.

9. Barrett's L 2.

10. Barrett's D P, which is formed, as are all the others (except the Scotch and the old Oxon), of a cast-iron body and wooden beam and handles, and which possesses a whole mould-board, while the rest, with the exception of N L 7 and the Scotch, had a ground-wrest attached.

11. A Warwickshire iron double plough, well constructed, but of great weight. I have taken the liberty of putting down Barrett's double plough, though not present; and of stating it at double the draught of D P, which I am confident, from the experience I have had with it, would have been as nearly as possible the number of stones it would have exhibited had it been tried on the present occasion.

These single ploughs were all tried on the 3rd of March on a wheat stubble, in a gravelly sandy loam, after a good deal of wet; and the results following were noted down by those present. The furrow was kept at 9 inches wide and 5 inches deep:—

	Stones.
1. Cuddesden, Oxon, old one-wheel	22
2. Burcott, do. do.	22
3. Scotch swing-plough	20
4. Barrett's No. 8 two-wheel, with Ransome mould-board	20
5. Barrett's No. 8 one-wheel, with Brightwell mould-board	19
6. Watlington, Oxon, one-wheel	18
7. Hart's one-wheel	17
8. Ransome's N L 7, two low wheels	16
9. Barrett's L 2, one-wheel	15
10. Barrett's D P, one-wheel	13

Double ploughs.

Warwickshire double plough, iron	38
Barrett's double plough, wooden beams	26

There is nothing particularly new in this experiment: it is similar in many respects to the one I have detailed before, and it resembles one or two of the trials you have* already recorded in the Journal. Its value consists chiefly in confirming the results previously arrived at, and going some way I trust in establishing them.

1. It is premised, as placed beyond a doubt, that the draught-gauge, properly constructed, is an unerring test of the amount of draught required by an implement, and of work performed by an animal or other moving power, and as such is useful as a practical guide to every farmer.

2. It is made clear that the vague principles of village plough-making must give way to the better defined and more economical system of more instructed practitioners.

3. It is shown that the wheel has a decided advantage over the swing plough, and that this must necessarily be the case, on plain mechanical principles, I will show in another place. The superior science of the Scotch plough, displayed particularly in its mould-board, is from this defect obliged to yield to less perfect implements.

4. That a great majority of the improved wheel-ploughs have hitherto been constructed so little with a view to lightness of

* Trial iii. p. 228, vol. i. Part iii. Journal.

draught that a large portion of the cost of ploughing is needlessly wasted.

My friend with the old wooden plough could not but come to the conclusion that he had been ploughing at a great unnecessary expenditure, and declared that I should be the cause of putting him to the farther expense of a new plough, and that the lightest in draught.

Ransome's N L 7 exhibited here the same draught that it did in similar soil and circumstances in your trials. What surprised me was the position which Hart's plough assumed; and it was to satisfy myself that I had been making a trial of the correct implement, that I requested the loan of your plough; and for greater satisfaction I sent it over to Mr. Chillingworth of Cuddesden, from whom I had the one I made this experiment with, to be compared and tested with his. The result which he and Mr. Gale returned to me perfectly verified our previous trial. Yours and two other Hart's, in Mr. Chillingworth's possession, in a sandy loam furrow 9×5 , all agreed on the draught-gauge, *i.e.*, were each 17 stones, at the same moment that D P, which I also sent over, exhibited 13 stones, being exactly the places both were found in at the trial on the 3rd of March. The Scotch, which was I believe in this instance of an excellent make, was held by its own, a superior ploughman. To the swing principle, and in some degree to its weight of iron, we must, I think, attribute that inferior position with regard to draught, which till of late it has not been suspected to hold. Barrett's D P justified the favourable judgment it had received, and corresponded with my previous experience of it. The ploughs 4, 5, and 6 serve to show the drain on farmers' resources that extensively exists by the use of implements of unnecessary draught.

Comparative Experiments during Barley-sowing.—I have taken the opportunity afforded by the loan of your plough to carry on a few trials with it during my tillage for barley along with three others, Barrett's L 2 and D P, and Ransome's N L 7, which my neighbour Mr. Davey allowed me to retain.

The soil these four ploughs have been tried in is a fair gravelly loam that generally works well, but is rather sticky when wet, and sets hard when dry. The first trial (April 2nd) occurred while the seed-furrow was given to a well-pulverised surface on which the barley had been cast.

The next trial (April 3rd) was during the breaking up of some turnip ground after sheep, which had been more or less trodden in a wet state; and the surface had become dry and *scrubbed*, but was moist enough beneath. The spots trodden in the rain, and those slightly *poached*, have been noted separately.

The third trial (April 20th) made in the same field and under

the same circumstances, except that the soil had become much harder and drier throughout.

The fourth trial (April 11th) in which the hard trodden surface had been previously single-horse ploughed and reduced.

The fifth trial (April 20th) during the stirring for barley (second furrow) with single horse, 4 inches deep, upon a surface harrowed and rolled.

I made several minor experiments besides, to verify these, as well as for objects not immediately connected with our present inquiry. I made also several trials in order to arrive at some analysis of draught: they were made almost entirely by myself, assisted only by my man. I noted no draught down till my mind was perfectly satisfied about it; and where there was room for doubt I threw the advantage to the side against which the test seemed to be going. There is a fifth place given to Hart's second mould-board, a whole one, to compare it with its more commonly used open one with detached ground-wrest.

Comparative Experiments with Four light Draft Ploughs.

	Ransome's N L 7.	Hart's.		Barrett's L 2.	Barrett's D P.	Furrow.	
		With Gnd.-wrest.	Whole Mould-bd.				
	Stones.					in.	in.
I. Apr. 2. Seed furrow, with single horse	10½	9	..	10	8	2½	× 8
II. Apr. 3. Breaking up turnip-ground trodden in rain	23	21	22	22	19	5	× 9
Ditto. Breaking up turnip-ground less trodden	19	18	20	20	17	5	× 9
III. Apr. 20. Breaking up turnip-ground, drier and harder	..	25	26	25	20	5½	× 9
IV. Apr. 11. Surface previously single-ploughed	..	19	..	19	17	5½	× 9
V. Apr. 20. Second furrow, with single horse	11½	12	11½	11	9	4	× 9

While the open mould-board of Hart's was a full stone lighter than the whole one, the reverse was the case with D P, which has a similar form of mould-board to shift. This arises, I believe, from greater fulness in the breast of Hart's open one.

The comparative Average of each Plough, first, on the three occasions in which they were all engaged together; then, where three ploughs only were together, throughout, I think will be found as follows:—

Average of Three Trials.

	Stones.
Ransome's N L 7	17 ⁵ / ₆
Hart's whole-board	17 ⁵ / ₆
Barrett's L 2	17 ⁴ / ₆
Hart's with ground-wrest	17
Barrett's D P	15

Average of every Trial.

	Stones.
Barrett's L 2	17 ⁵ / ₆
Hart's with ground-wrest	17 ⁵ / ₆
Barrett's D P	15

It would be desirable to prosecute these experiments in wet seasons and in more adhesive soils. I have little doubt that D P will generally be found lighter than Hart's; in comparing the two ploughs together, it is evidently constructed for lighter draught.

Having satisfied my own mind about the relative position of the above four ploughs, I was led on to inquire a little into the cause of the difference, and thence to attempt to analyze the draught of ploughs as connected with the swing and wheel principle; but, learning that the early publication of the Journal does not admit of my completing my experiments, I will reserve them (if thought sufficiently practical), together with other matter that I have promised in the course of this paper, for a future occasion.

And believe me, dear Sir,

Yours faithfully,

HENRY J. HANNAM.

Burcott, May 12, 1842.

III.—*Account of a Field Thorough-drained, at Drayton, in Staffordshire.* By the Right Hon. Sir ROBERT PEEL, Bart., &c. &c.

To Ph. Pusey, Esq.

MY DEAR SIR,—I comply, with the greatest pleasure, with your wish that I should give you the particulars respecting the field which I drained and subsoiled, the produce of which was sent to you by our common friend Dr. Buckland.

I was riding with him over a part of my estate in the autumn of 1840. He remarked a quantity of manure put upon a field, of poor soil, very wet, and in bad condition generally, and said, the tenant who placed it there went to very needless expense, for that manure would be of no service while the land remained undrained and in the state in which it then was.

He said also, that the land in Scotland which had been so much improved by Mr. Smith, of Deanston, was naturally no better than that on which we were riding, and that in its original state it resembled that land in respect to the quality and properties of the soil in many particulars.

These remarks of Dr. Buckland did not pass unheeded. I selected the worst field I could find, and determined strictly to follow the plan of Mr. Smith in respect to it, so far as draining and subsoiling are concerned. I first proposed to the tenant that he should retain the field and do the work under my directions;

but he thought it too expensive for his means, and preferred giving up the field and letting me take it into my own hands.

Inclosed are the details with respect to the mode of treatment, conveyed in answers to queries put by me. The produce you have, I believe, from Dr. Buckland. The weight given is of the turnips, with the tops, but without the fibrous roots. I was advised by very good practical farmers not to sow turnips, but to have a fallow for wheat: they thought the land not very well suited for turnips, and that the best period for sowing them was gone by. But I was desirous to exhibit the result of my experiment; which I had mainly undertaken for the purpose of encouraging others in my neighbourhood to follow my example. For that very reason, perhaps, I ought to have been less impatient.

However, the turnip crop on one half the field far exceeded my expectations; and the comparative failure on the other was clearly attributable to special causes.

Believe me, my dear Sir,
Very faithfully yours,

ROBERT PEEL.

Whitehall, Jan. 13, 1842.

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|--|---|
| 1st.—What was the nature of the subsoil in different parts of the field? | About one-third of the field was stiff clay; the other part was a mixture of hard sand and gravel. |
| 2nd.—Was not the upper soil of a peaty nature? | Yes. |
| 3rd.—What was the general depth of it above the subsoil? | From 4 to 6 inches. |
| 4th.—Was that the best part naturally of the field where the best crop of turnips was? | No: the greatest portion of it being stiff clay. |
| Or was the difference of produce in different parts of the field entirely arising from other causes? | The difference of produce arose from two causes; viz., very heavy rains at the time of sowing, and the wire-grub. |
| 5th.—Was the field very dry during the continued heavy rains of the season of 1841? | Yes; very dry. |
| 6th.—Did the drains act effectually? | Yes. |
| 7th.—What was the depth of the several drains and main drain? | Main drain, from 5 to 6 feet.
Sub-main . . . 3 to 4 „
Other drains. . . 2 feet 6 in. deep. |
| 8th.—When was the draining finished? | 30th of April, 1841. |
| 9th.—What was the time when the turnips were sown? | Hertfordshire Whites, 21st of June.
Red Giant 23rd „
Red Top 24th „
Globe 25th „ |
| 10th.—Was it the last sown that failed? | Yes; the 24th and 25th of June. |

11th.—How were the tiles laid?

The drains being cut to their proper depth, and the tiles laid in, a thin covering of brushwood (spruce and Scotch firs) was laid upon them, and 6 inches in depth of small pebble-stones was laid upon the brushwood, a thin layer of turf (grass side downwards) was laid upon the stones, and then filled up with the gravel or sand and soil which had been dug out of the drains.

12th.—What is the size of the field?

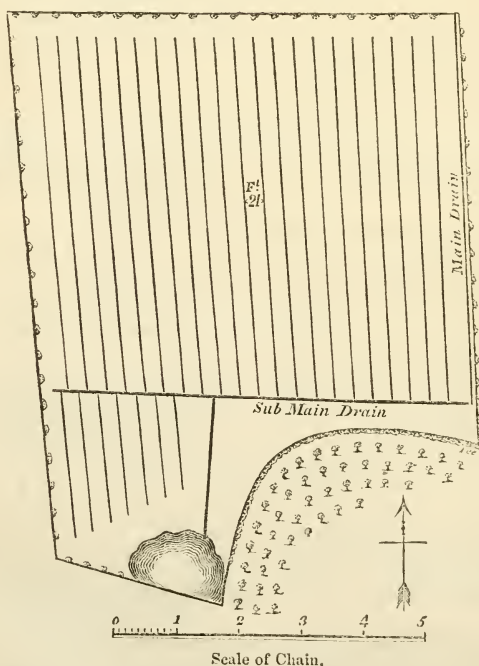
Five and a half acres.

13th.—What was the condition and average produce before draining?

The preceding crop was oats, and seeded down with clover and grass seeds, which was almost a failure. The average produce of the oats was 4 bags per acre; the turnips were a mere brush crop; the wheat about $6\frac{1}{2}$ bags per acre.

14th.—What manure was used on the turnips?

20 tons of lime were spread on the surface of the whole field, and 12 tons per acre of farm-yard manure.



The field was twice ploughed with a single plough, then harrowed, rolled, and cleaned, ploughed again with a single plough, and followed by the subsoil-plough.

After the field had been drained upon Mr. Smith's plan, or nearly so (the principal difference being that the whole of the drains had *drain-tiles* placed therein, and Mr. Smith only names the main and sub-main to have drain-tiles), it was then limed with 4 tons of good lime per acre; then it was ridged up; afterwards the ridges were split or opened with a plough, and rotten dung placed within the ridge or split: it was immediately moulded up into ridge again, and the seed drilled on the ridge directly over the dung, so that the seed had the full benefit of the dung at the first stage of vegetation.

I believe I can confidently state that the crop of turnips, after the above treatment, was four times the quantity in weight ever produced in the same field at any previous time.

As to the quantity and the quality of the manure used, the manure was good town-made stable manure and your own good farm-yard dung, mixed; the proportion used was 12 tons per acre.

The best crop (27 tons per acre) was the Hertfordshire White: sown 21st of June.

The second best (26 tons) was Mr. Skirving's Red Giant: sown 23rd of June.

The next best was the Red Top: sown 24th of June: about 16 tons.

The next best the White Globe: sown 25th of June: about 16 tons.

The whole of the seed was from Mr. Skirving, of Liverpool; and 2½ lbs. of seed per acre was sown; and the ridges were 24 inches distant from each other.

No portion of the field was either pared or burned.

The distance between each drain is 21 feet. The strong clay which was dug out of the drains was spread upon the peaty soil, and was considered almost as good as a dressing of manure.

Every drain was open throughout before any tile was allowed to be laid; and the field was almost free from water when the tiles were put in. The field was in a wretched state before, as to wet.

(Signed) THOMAS HILL.

The Rt. Hon. Sir Robert Peel, Bart.

IV.—*On the Connection between Geology and Agriculture in Cornwall, Devon, and West Somerset.* By Sir Henry T. De la Beche, Director of the Ordnance Geological Survey.

[*From his General Report on the Economic Geology of that district.*]

It can scarcely escape the most casual observer, that the fertility of this district varies most materially, and that very striking contrasts in the productive character of the soil present themselves to his attention in different parts of it. If he will take a geological map in his hand and compare this variation in fertility with the colours marked upon it, he will scarcely fail to find that there

is an evident connection between the greater or less productive-ness he may have noticed, and the areas differently tinted in the map. Those who examine more minutely into the subject will soon perceive that this coincidence extends very generally to the boundary-lines of the various colours ; so that, if the scale of the map be sufficiently large, the relative fertility may, in some cases, be traced even across fields, portions of them being far more productive than others.

In endeavouring to estimate the relative amount of fertility that may be due to the decomposition of the subsoil rocks, it is essential that due attention be paid to local conditions as regards aspect, height above the sea, and other necessary circumstances, otherwise many erroneous conclusions may be drawn, especially in a country like that we are now noticing, in which so many places are exposed to the influence of the sea-winds, and where heights vary considerably. We should necessarily expect that sheltered situations, with a good southern aspect, would be those in which, all other things being equal, we should find the capability of any given soil best exhibited ; and that hence, by comparing localities as nearly alike in this respect as we can find them, we may be the better able to observe any differences which may arise in soils from the mineral structure of the subjacent rocks.

Fortunately there are many short valleys on the southern coasts of Devon and Cornwall, the component parts of which do not so materially vary in latitude as to render their temperature on that account, to any very important extent, different, where the general atmospheric conditions are so nearly similar, that the relative fertility of the soils in them may be fairly appreciated, due allowance being made for the greater prevalence of cloud as we proceed westward, viewing the district as a whole. At Lyme Regis we have a lias valley, and at Sidmouth one formed of red marl and sandstone, both bounded by hills of green-sand, and both much strewn over in places by flint and chert-gravel. The superior fertility of the Sidmouth valley is readily seen, though of the two it is most exposed to the northerly winds. Independently of the decomposed lias being less favourable to general cultivation, though it is commonly valuable for grass-land, the geological conditions of the two valleys are such that, while the rain-water, which percolates through the green-sand on the tops of the bounding hills, is allowed to pass through the red sandstones in the valley of Sidmouth, being thrown out only by the marls, the lias in the valley of Lyme throws it out altogether, producing landslips and much wet ground.

If we compare the short valleys, with a southern exposure, of Lamorna Cove (on the west of Penzance), in granite, of Chyan-

dower (near the same town), in greenstone and slate, of Kennack Cove (Lizard), in serpentine, of Pendowa (near Veryan), in ordinary schistose grauwacke, of Polperro, chiefly in variegated clay-slate, and several others in different varieties of grauwacke, with each other and with those of Sidmouth and Lyme Regis, we can scarcely doubt that their relative fertility, and their power of growing particular kinds of plants to advantage, greatly depends upon their subsoil rocks.

That shelter from the prevalent sea-winds, which strike so many parts of the coasts of Cornwall and Devon with great force, is important to the vegetation of the district, will be amply testified by the bent and stunted character of such trees as can be made to grow exposed to their influence, and by the fine appearance of those which flourish freely when defended from them, even when they closely approach the sea, as at Newlyn, near Penzance, at Mount Edgecumbe, near Plymouth, and at Dartmouth. It will be observed, in the continuation of the same range of rocks, that, while the portions which are exposed to these prevalent sea-winds will scarcely support the growth of more than a few bent and stunted shrubs, the sheltered parts are covered by vegetation in proportion to the fertility of the rocks of the locality.* Let, for instance, the vegetation on the mica slate and chlorite rocks of the Molt, at the entrance of the Kingsbridge estuary, be compared with that on the continuation of the same rocks in the Sewer valley, opposite the Ham Stone, and we shall find flourishing gardens overhanging the sea in the former situation, orange and lemon trees growing in the open air, with little shelter during the winter, though the Molt is exposed to the south-east; while in the latter trees and shrubs are completely cut up where exposed to the south and south-west winds. For similar reasons fine woods clothe the coast near Clovelly, in North Devon, though its aspect is northern; while the continuation of the same beds of the carbonaceous series, near Hartland Pier, will scarcely support the growth of a tree when exposed to the western winds. So also the Culbone woods, near Porlock, which rise gradually from the shore, and flourish with

* Mr. Worgan, in his 'General View of the Agriculture of Cornwall' (1811), p. 47, calls the attention of farmers to the value of the tamarisk for fences in situations exposed to the brunt of the sea-winds, where scarcely another shrub will grow in the hedges. We have observed good fences of this plant on the south, near Landewednack (in the Lizard district), and around Harlyn House, near Trevoze Head, on the north. Hence it is probable that it might, notwithstanding this plant suffers from frost, be successfully cultivated along a large portion of the coasts of Cornwall. As it is, this useful tree is sparingly found. It is probable, also, that it would thrive along the southern shores of Devon, as it grows fairly in some gardens close to the sea at Lyme Regis.

a northern aspect, would be speedily swept away, or be contorted and stunted in their growth, if exposed to the full force of the same winds.

Though, from the want of friction, beyond that which they receive from the surface of the sea, the prevalent sea-winds act most severely on the coast vegetation exposed to them, preventing that growth which adjacent sheltered spots show the decomposition of the same rocks to be capable of supporting, their influence is not confined to the coasts, but extends inland in proportion to distance from the sea and height above it. Many a valley, therefore, in a given range of rocks, is comparatively fertile; while the high grounds in the same range make a poor return for the labours of the agriculturist.

The chalk of the district is seldom exposed on the surface, and therefore contributes little by decomposition to the superjacent soil; hence we find no area of importance presenting the marked agricultural character of the chalk portions of the adjacent counties on the eastward. The chalk and green-sand are, indeed, generally so completely covered by gravel that the parts represented in maps as composed of these rocks afford a very common agricultural character, and cannot, on the whole, be considered fertile. Downs of heath and furze are very common upon these gravels; and those portions cultivated as arable land abound in flints and fragments of chert. The gravels also frequently contain much clayey matter intermingled with them, so that water does not readily percolate through them, and black peaty soils are often observed. In places where marls, probably the remains of the plastic clay beds, are found near the surface, the agricultural character of the land above the chalk and green-sand is much improved, and the country more fertile. In those situations in the Black Downs, where the gravels have not descended thickly spread over the sides of the hills upon the red marls, or lias, beneath the green-sand, the contrast offered between the agricultural condition of the country, upon the one and the other, is remarkably striking; indeed, a well-marked line of heath and common nearly coincides with the division between the two rocks. Haldon Hills also afford good examples of the contrast between the vegetation upon the green sands, with their gravel covering, and upon the rocks beneath them.

When the agricultural character of the lias is compared with that of the red marl and sandstone adjoining it, a very striking general superiority is observed in the latter. Good opportunities for observing this circumstance are afforded by the Vale of Taunton, where both rocks occur under similar general conditions as to climate. It will be seen also in the neighbourhood of Bridgewater, in that of Watchet, and near Uphill and Worle, in the vic-

nity of Weston-super-Mare, on the north, and in the valley of the Axe on the south. Excellent grass-land is often seen on the lias, as also many good orchards; but in general the arable land upon it seems not very remarkable for abundant produce. Oaks, as might be expected, often grow well, particularly upon the marly or clayey parts.

Taken as a whole, the area occupied by the red sandstone series is one of considerable fertility, especially when uncovered by transported gravels. The red marls, with their higher variegated parts adjoining the lias, would appear very favourable for the growth of apples; and the cider obtained from their range is commonly found to be very excellent, when sufficient attention is paid to the mode of making—an attention not so common as could be desired. The cider obtained from the red and variegated marls of the Vale of Taunton, and that made in the valleys of the Otter, the Coly, the Yart, and the Axe, where they cut into the same beds, and the surface is fairly clear of gravel, may be taken as examples of this circumstance. In many places, also, where beds of red marl are intermingled with the sandstones and conglomerates of the other parts of the series, or the latter contain much marly matter, the same fact will be observed. Some of the best lands in Somerset and Devon are upon the red sandstone series; and the general rich appearance of the vegetation it bears, more particularly where the soil is directly based upon it, so that its component parts have been superficially decomposed to form the chief part of such soil, is one of the marked features of the country. No doubt, as these component parts vary, so does the fertility; but there are few soils of any great extent, composed really of decomposed portions of the red sandstone series, which are not rich in general products. Their different porosity certainly causes minor variations, some of the marly grounds being inclined to be wet, while some of the sandstone grounds are too dry. The upper beds are most disposed to be wet and clayey, while of the too great porosity of subsoil rock the localities are more scattered.

We next find a contrast between the fertility of the soil on the beds of the red sandstone series, and of that on the rocks upon which it rests, which is marked and striking, and much in favour of the former. As the country formed of this series generally occupies a lower position than that composed of these subjacent rocks, it may be said that it is more sheltered, and that often this contrast is deceptive, the lower and less exposed portions of ground deriving the usual advantages from position. If, however, we take the country between Tiverton and Bradninch, where beds of the red sandstone are mingled on the surface with those of the carbonaceous series, at equal heights and under similar general conditions as to climate, or that near Cadbury and Stokeleigh

Pomeroy, where the former occupy the highest ground, their superior fertility is not the less marked. If it be said that this is not a fair comparison, inasmuch as the beds of the carbonaceous series are generally far from affording a good soil, we may take the country between Totnes, Torbay, Babbacombe Bay, and Newton Bushell, where the red sandstone series is intermingled, under similar conditions as to height and climate, with grauwacke slates and limestone; and except trappean rocks occur among the latter, the same circumstance will be observable.

The soil on the carbonaceous series generally is far from good, though here and there more fertile spots may be found, as in some places near Bideford, Tiverton, and a few other localities, particularly where the beds are red. In those situations, also, where trappean rocks are mingled with them, as near Launceston, Milton Abbot, and Tavistock, on the west, and near Bridford, Cristow, Ashton, and Trusham, on the east of Dartmoor, their condition seems often much improved, the wash of the decomposed parts of these trappean rocks often passing over them. The country between Launceston, Hartland, and Okehampton is among the most dreary and barren in the district, a poor yellow clay being a very common product of the decomposed shales and sandstones there found, for the grains of the sandstone are frequently cemented by matter which thus decomposes. The land, moreover, is generally high, and down succeeds down in monotonous succession. The country improves in appearance in the range of these rocks to the eastward; still, however, as a whole, its general character is not fertile, as a journey from Barnstaple to Tiverton will readily show. Oaks flourish well upon these rocks in several situations, and might probably be successfully raised in many valleys now almost uncultivated.

From the very variable mineralogical character of the grauwacke, we might anticipate the very great difference observable in the country occupied by that rock, every due allowance being made for the varied meteorological conditions to which it is exposed according to locality. On the north, the hard sandstones of the Foreland, and those extending from the Hangman Hills to Croydon Hill, on the south of Dunster, form such high land, that, for that reason alone, we should not expect much successful cultivation; but in the lower and more sheltered situations little fertility is observable: indeed, there are few among these sandstone beds which would be readily decomposed at their exposed surfaces. The agricultural character of the lime-bearing band of schistose rocks extending from Ilfracombe and Combe Martin, by Exford, to Nettlecombe, near Monksilver, is much superior to the last, and very fair land may be seen in the less elevated and sheltered situations. The next band of grauwacke, ranging from the coast

between Ilfracombe and Bull Point, on the south of the last, is, again, less fertile, while that which succeeds it in the ascending series, and which is chiefly composed of fine argillaceous slate, is generally not much inferior; being, however, liable to form a clayey soil where the natural drainage is not good. The next band, principally formed of sandstones, and ranging from the coast at Morte Bay and Baggy Point, to Heydon and Main Downs, near Wiveliscombe, presents generally a poor soil; while the band above it, extending from the vicinity of Barnstaple, by Dulverton and Raddington, to Bathealton, and which is often calciferous, is frequently fairly fertile.

On the south, the differences of soil, from variations in the mineral structure of the grauwacke and its associated trappean rocks, is still more remarkable; and we may here observe that the latter rocks, which are chiefly compounds of hornblende and felspar, afford the most fertile soils of any in the district, when their decomposition has taken place to any sufficient depth; so much so, that when much disintegrated, they are sometimes worked as marl-pits for manure, and the land thus treated is always found to be greatly benefited. The trappean ash, particularly when mingled with calcareous matter, which is sometimes the case, affords a remarkably fine soil.* The trappean

* I had an opportunity last autumn of observing this trap-rock at my friend Sir Thomas Acland's place near Exeter. In the quarry it has the appearance of volcanic lava, and sometimes of ashes; and though its fiery origin is infinitely more ancient than any existing volcano, you might suppose while standing on it that you were at the foot of Vesuvius. The stones from this quarry at Killerton had been found to act excellently as a dressing for corn-land; and the soil over this rock was stated by the bailiff to be worth 10s. an acre more than the neighbouring land. Professor Johnston has found the same circumstances in Scotland. "In the neighbourhood of Haddington," he says, "I have seen a farming-tenant removing 12 inches of *trap* soil from the entire surface of a field for the purpose of spreading a layer of an inch in depth over twelve times the area in another part of his farm." "The same general character," he also states, "is exhibited by the trappean soils of other parts of the island. The height of the Cheviot Hills renders the climate in many places unfavourable to arable culture, yet they produce the sweetest pasture, while the low country around them has been largely benefited by admixture with their crumbling fragments. The whole of that lowland tract of Scotland over which these rocks extend, comprehending the counties of Ayr, Renfrew, Lanark, Linlithgow, Fife, and portions of Perth, Stirling, Edinburgh, and Haddington, exhibit the fertile or fertilising character of the decomposing greenstone. Professor Johnston informs us that, according to Dr. Rüppell, the only fertile tracts of Abyssinia are found in valleys and on mountain slopes, where the soil is composed of the washings of trap-rocks; and he adds, "The more modern volcanic lavas, which overspread Italy, Spain, and Germany, are closely related to the trap-rocks in their general composition, and the fertility which overspreads thousands of square miles of decomposed lava-streams and ejections of volcanic ashes in Italy and Sicily is too well known to require any detailed

rocks in Devon and Cornwall are very commonly known by the name of *dunstone*, the harder being not unfrequently termed *iron* or *ire stone*, particularly in the latter county. Much of the vesicular trap and trappean ash is known as *honeycomb dun*, especially in Devon, and land upon it is always highly esteemed by the farmer. Mr. Worgan ('View of the Agriculture of Cornwall,' p. 10) observes, that wherever the dun, or ironstone, is met with in Cornwall, "it is deemed a fortunate circumstance, being a certain indication of the fertility of the incumbent soil." Limestone occurs in sufficient abundance in the vicinity of Torbay, Newton Bushell, and Plymouth, to afford an agricultural character. The land upon it is generally considered good, but it is frequently light, and, from the hardness of the subjacent rock (though its surface is often broken into fragments from atmospheric causes), liable to be washed away in exposed situations. In this respect it agrees with the carboniferous limestone on the north of the district, near Weston-super-Mare and Uphill, as might be expected from the similarity of their mineral composition. The range of the red and variegated slaty beds of the *grauwacke* may, upon the whole, be considered as among the most productive of that series in Cornwall and Devon, and very frequently much barley is successfully grown upon it. Thus, much barley, often malted, is exported from Kingsbridge and Padstow, grown upon the red and variegated slates of the country adjoining those places. The red slates, particularly when they contain some calcareous matter, are favourable also to the growth of apples, as upon the banks of the Dart and Fowey.

As in the north, in those localities where the sandstones prevail, there is less fertility than where slates occur. According to the general mineral composition of the latter is also their character of heavy or light; those most approaching to clay slates being liable, where the drainage is imperfect, to become clayey. They generally support a fine growth of oak, as is well seen in the numerous sheltered valleys of southern Cornwall and Devon. The band of *grauwacke*, including the associated limestones and trappean rocks, which ranges from Ashburton, Newton Bushell, and Torbay, between the granite of Dartmoor and the mica slates of Marlborough and Chivelstone, to Plymouth, and thence along

description."—Johnston's Agricultural Chemistry, p. 386; where the exceptions to the general rule are stated. Dr. Buckland informs me that, in July, 1840, being on a visit at the place of Sir C. Menteith, Closeburn, in Dumfriesshire, he observed on a moor lately reclaimed from heath, and then covered with coarse grass, a band of bright emerald-green herbage stretching across it. This band marked the underground course of a trap-dyke, traversing slate-rocks, called Devonian, from their prevalence in Devonshire.—PH. PUSEY.

the southern shores of Cornwall by the Looes, Fowey, Veryan, and Falmouth, to the northern part of the Lizard district, may be considered, upon the whole, the most fertile part of the Cornish and South Devon grauwacke, especially the more eastern part between the Tamar, Torbay, and Newton Bushell.* Other minor areas, no doubt, afford equally good land; as, for instance, the vicinity of Penzance, a tract, the superior fertility of which has been pointed out by Dr. Paris, and correctly referred by him to the decomposition of the greenstone rocks which there abound. He states that, when he wrote (1818), a belt of land around that town, of 1000 acres, produced an annual rent of 10,000*l*.†

The mining districts have often a very barren aspect, independently of the destruction of vegetation produced by mining operations on the surface. We have frequently found the ground covered, in such situations, by a thin bed of quartz fragments, composed apparently of the parts of those minor veins which often abundantly traverse such countries in different places. It would appear as if, during the decomposition of the general surface by meteoric influences, and the removal of the finer particles of the slates by rains, these fragments had gradually accumulated on the surface, rendering it even less fertile than it would otherwise be.‡

Judging from the Lizard, the soil on the serpentine is far from fertile, frequently retaining the water on its surface, so that swamps and marshy places are common. Even on the slopes of the hills, where the natural drainage is good, little can be said for

* A portion of this rock, near the Tamar, between Tavistock and Launceston, where it is called Skiliot, affords a soil of singular fertility, the grasslands yielding often from 2 to 3 tons of fine hay, principally consisting of white clover. On the pasture it is affirmed that an ox will, from being quite poor, get moderately fat in ten weeks. As arable land, many parts are too forcing for the growth either of wheat or potatoes. An exact analysis of the soil and subsoil of this district would be very instructive. The agriculturist must study the *constitution* of his patient the soil, if he would understand where its strength or weakness lies.—F. FALKNER.

† Observations on the Geological Structure of Cornwall, with a view to trace its connection with and influence upon its Agricultural Economy, and to establish a rational System of Improvement by the scientific application of Mineral Manure.—Trans. Geol. Soc. of Cornwall, vol. i., p. 188.

‡ Quartz is commonly known by the name of *spar* in western Cornwall, and as *whiteacre* in eastern Cornwall and part of Devon. Mr. Worgan, noticing the loose quartz fragments of various sizes dispersed over the surface in many parts of Cornwall, and that it may be sometimes profitable to remove them, states, that “Mr. James, of St. Agnes, cleared a large field of spar, by screening the whole mass of spar and earth, as deep as the yellow substratum, in the same manner as masons screen the earth for their mortar; and the experiment answered well, although it cost 40*l*. per acre: the land was afterwards let for 3*l*. per acre, and the stones were purchased to make a road.” (View of the Agriculture of Cornwall, p. 11.)

its agricultural qualities, though we have here and there seen some fair grass land, and better corn crops than might, at first sight, be anticipated. As is well known, the serpentine of the Lizard offers a marked example of a particular plant, the *Erica vagans*, a very beautiful heath, keeping to the soil upon it, so that the boundary of the serpentine against the other rocks may be fairly traced by its aid; indeed this plant is rarely found beyond it. The general barren character of the serpentine of the Lizard contrasts very forcibly with the soil on the adjoining diallage rock and sienite, among the most fertile, if not the most fertile, of the lands in the district. As Dr. Paris observes, "the lands between the church (of St. Keverne) and Coverack Cove constitute one of the most extraordinary districts in the kingdom, presenting a rare combination of rudeness and fertility; gigantic boulders of sienite (and diallage rock) lying scattered in all directions, and yet, in point of luxuriant fruitfulness, this country may be denominated the garden of Cornwall."* It affords, indeed, a good example of the unequal decomposition of a rock, so that while it is sufficiently disintegrated in places, that pits may be formed, and the decomposed rock taken away for manure, in others hard blocks are scattered over the ground or rise in tors through it; and it also exhibits an instance of the fertility of a soil chiefly derived from the decomposition of hornblende, or diallage, and felspar, the crystallization being large-grained.

The hornblende slate and rock of the Lizard is also extremely fertile, contrasting strikingly with the serpentine, which it bounds in many places, and through which it, indeed, rises in small patches in one or two localities, so that it is necessary not to confound the more abundant vegetation upon it with a growth upon the serpentine. Some land near Lizard town, upon hornblende slate, was, after being enclosed, not manured for several years, though frequently cropped with barley and wheat; so fertile is the soil upon that rock. No doubt, from the mild temperature of the Lizard district, where snow is rarely seen to rest upon the ground, vegetation may possess advantages upon a given rock, which it would not have in colder parts of Cornwall or Devon; but as at the same time it is much exposed to sea-winds, which often sweep over it with great fury, and as the slates, greenstones, hornblende rocks, diallage rock and sienite, serpentine, and talcomicaceous rocks are all exposed to the same conditions, the contrast afforded by the varied fertility upon these mineral compounds is highly instructive, and illustrative of the fact, that soils do, all other things being equal, mainly depend on their subjacent rocks for their agricultural character.†

* Trans. Geol. Soc. of Cornwall, vol. i., p. 189.

† Speaking of the fertility of some lands in Mullion and other places near

Dr. Paris has pointed out that the relative fertility of the granitic soil of Cornwall would appear greatly to depend upon the abundance and easily-decomposable character of the felspar in the subjacent rock; and he has also remarked that the relative proportion of mica would seem to have an appreciable effect upon such soils, tending to render them poor, while the iron in some may become a useful element in them.* Our own observations would tend to confirm this view, due allowances being made for exposure to atmospheric influences. These would, however, seem very considerably to influence the agricultural character of the granitic or *growan* soils,† as they are generally termed. For instance, we have been unable to detect any appreciable difference between much of the granite on the high land of Dartmoor and that in the Scilly Islands, in places where both were well decomposed. In the Scilly Islands, particularly in St. Mary's, there is much *growan* land which is fairly fertile, producing good crops of potatoes, wheat, barley, and grass, while Dartmoor is merely covered by heath and coarse grass, and peat is abundant. In one case we have islands in the Atlantic of small relative height, and upon which it is rare to see snow; while in the other there is an extensive area in the interior, varying from 1400 to 2000 feet above the sea, on which fogs are frequent, and snow often falls and rests before it is seen on the lower grounds. The country around Moreton Hampstead, several hundred feet lower than the mass of Dartmoor, of which it is the geological continuation, being composed of a portion of the same mass of granite, forms a striking contrast as to fertility with the high land on the west of it. The grass land is generally good, tolerable crops of barley are obtained from it, and the potatoes grown are very highly esteemed and readily purchased at the Exeter market, one to which the products of many fertile lands are brought; yet the general character of the granite round Moreton Hampstead, and of that upon much of the adjoining high land of Dartmoor, is mineralogically the same.

Judging from Devon and Cornwall, there are few soils which are more affected by relative elevation above the level of the sea, in the climate there found, than the *growan*, or granitic soils. No doubt there may be some variation in the mineralogical cha-

the Lizard, Dr. Borlase notices that in his time barley had been sown, and that "in nine weeks commonly, oftentimes sooner, they have had it again in the sack, fit for market. This quick return," he continues, "is not owing to any particular sort of barley, but to the soil and situation, and a kindly warm season, the nights in the summer time on the sea-coasts being seldom or ever cold."—Natural History of Cornwall (1758), p. 87.

* Trans. Geol. Soc. of Cornwall, vol. i., pp. 173, 174.

† *Growan* is the Cornish name for gravel.

racter of the subjacent granites, and, consequently, in their relative productiveness; but, nevertheless, there is a constant and prevailing kind of granite which readily decomposes, and forms a large part, with the exception, probably, of the Hensborough boss, of that to be found in the whole of them. Between the relative fertility of the soil above this granite, according to locality, very useful comparisons may be instituted. Dr. Boase has indeed already remarked that the fertility of the granitic groups of Cornwall gradually increases as they diminish in elevation,* an observation which may very properly be extended to Devonshire. The granitic or growan soil is one which frequently requires rain, of which, however, there is no want generally in the district, and the grass grown upon it is considered good for feeding cattle. Under fair conditions as to height and exposure, it is very commonly celebrated for producing good potatoes.† Barley and oats are chiefly cultivated upon it where employed for arable land, wheat being rarely a successful crop except in a few situations, among which St. Mary's, Scilly, and land in the parishes of Burian, Sennan, and St. Leven, in the Land's End district, are the most remarkable.‡ Oaks, ash, and sycamores grow well upon the growan soils in sheltered situations, and where sufficient attention is paid; of which the grounds of Trebartha Hall, near North Hill, afford as good an example as any we can select.

Peat is very common upon the granitic soils, more especially where the land rises high. Dartmoor produces a large quantity of this substance, which is much employed as common fuel in the country adjoining it.

It has been considered that, at the junction of the granite and slates in Cornwall, the soil is considerably improved by the mixture of the decomposed portions of each rock; and Dr. Paris states that this fact is very observable in many places, more particularly pointing out the superior fertility of this kind of junction at

* Trans. Geol. Society of Cornwall, vol. iv. p. 365.

† Mr. Worgan observes that "if Cornwall does not grow wheat enough for its inhabitants, it certainly has the merit of supplying other counties with large quantities of potatoes."—(View, &c., p. 75.) He further remarks that, not only are many thousand bushels annually sent to Plymouth and Portsmouth, but that (in 1808) some shiploads were exported to London. Much of this produce is grown upon the growan soils, and the export would appear as considerable as ever. Indeed large quantities are now forwarded to London by the Dublin steamers which touch at Falmouth, and early potatoes are thus introduced abundantly into the London market. The vicinity of Penzance contributes largely to this early produce, chiefly there grown, however, upon the greenstone soils.

‡ Mr. Worgan states ('View of the Agriculture of Cornwall,' p. 9) that from 40 to 45 Winchester bushels of red wheat per Cornish acre have been raised upon the lands of these three last-mentioned parishes, the Cornish being larger than the common statute acre in the proportion of about 6 to 5.

Trengwainton, near Penzance, from Chyoon to Mousehole) famous for producing two crops of potatoes in the year), in the vicinity of Penryn, at St. Michael's Mount, and at Pendarves. This may no doubt be true in many cases, but it is far from being a general fact. Indeed we can readily perceive that the benefit of such a mixture must depend upon the mineralogical character of both rocks at their junction; now as these vary materially, so we should consider would be the agricultural value of the effect produced. Those parts of the Hensborough or St. Austell granite which contain much schorl, as a large portion of the western side does, are far from fertile, and the altered slate rocks in contact with them are often sterile, as may be seen on Fatwork Hill. The like may be seen on Castle-an-Dinas and Belovely Beacon. A large proportion of the skirts of Dartmoor is poor land, especially those parts which come into contact with the carbonaceous series. In those situations where the decomposed drift from the trappean rocks has mingled with the soil, as near Tavistock, Okehampton, Bridford, Cristow, and Hennock, the soil is much improved, and being close to the granite, so that the disintegrated portions of the latter are occasionally washed down and mingled with it at the same time, the opinion above noticed might appear to be more borne out in those situations than it really is. As the granite is more constant in its mineralogical character than the rocks which come into contact with it, and generally become more or less altered, often a sufficient reason in itself for their decomposed portions to be more fertile than they might otherwise be, probably the benefit that may be derived from any mixture of the growan and schistose soils mainly depends upon the mineral composition of the slates near their junction with the granite.

The alluvial lands, though generally fertile, vary, as might be expected, according to the mineralogical composition of the rocks from which they have been chiefly derived, as may be seen by comparing the flat lands bordering the rivers in numerous places. Let, for example, the alluvial land on the banks of the Culm, traversing red marl and sandstone, be compared with that between Sheepwash and Monks Okehampton on the banks of the Torridge, flowing among the carbonaceous series, or with many among the granitic districts, and there will be little difficulty in perceiving the superior fertility of the former. Numerous compounds would appear to be effected, in some places producing better soils than each rock separately affords: of this, probably, the alluvial lands among the limestones and slates of the grau-wacke may often be taken as examples. Wherever the rivers have held their courses amid easily decomposed trappean rocks, the usual grau-wacke compounds appear much improved. In-

deed, by carefully considering the rocks traversed by the rivers, and the kind of finer sedimentary matter likely to be borne down during floods, adding the relative amount of soil, in which there is already much animal and vegetable matter, that may be transported at the same time, and a fair average estimate may be formed of the relative agricultural value of alluvial lands. At the heads of estuaries much alluvial matter is necessarily accumulated, offering a more uniform character than it would otherwise do from the deposit of estuary mud in such situations, nevertheless presenting differences in the drier places according to the kind of sedimentary matter borne down by the rivers which respectively flow into them. The Bridgewater and Worle levels can scarcely be considered alluvial in the ordinary acceptance of the term, since a large part of them would appear regular detrital deposits upon the bottom of an estuary in which creatures usually inhabiting such situations lived and died, as they have done in many deposits now forming rocks. These levels support considerable numbers of fine cattle, and portions of them supply large quantities of cheese, generally known as Cheddar cheese, to Cornwall, Devon, and South Wales.

As connected with the economic geology of the district, we must not omit to notice the sea and blown sand which is extensively employed as manure in different parts of it. It is, as we have seen (p. 426), partly now thrown up and partly an accumulation at various points when the relative levels of sea and land were different from those we now find, the land having been apparently raised. It was employed, as now, for agricultural purposes, 236 years since, as appears by Carew's Survey of Cornwall (1602). Mr. Worgan, in 1811, estimated the expense incurred for the whole county in land-carriage for this sand at upwards of 30,000*l.* per annum.* Dr. Paris states it to have been ascertained that 4000 horse-loads have been taken from Bude in one day.† Not only is it carried from that place by the Bude and Launceston canal, with its branch extending to Holsworthy, the chief commerce on which is the conveyance of this sand, but it is conveyed over land abundantly in carts, so that a considerable portion of the adjoining portions of Cornwall and Devon are supplied with it from Bude. A good road has been constructed to Trebarwith Sands, on the coast near Camelford, purposely for conveying the sand there found into the interior.

* View of the Agriculture of Cornwall, p. 128. Borlase cites a letter in the Philosophical Transactions of April, 1675, in which the carriage of sand is estimated at 32,000*l.* per annum (Nat. Hist. of Cornwall, p. 48). Taking this sum and that given by Mr. Worgan as fairly accurate, and as Borlase did not object to a similar charge for the carriage of sand in his time, it would appear that it had remained nearly the same for about 140 years.

† Trans. Geol. Society of Cornwall, vol. i., p. 193.

Large quantities of sand are obtained upon the Dunbar in Padstow harbour, employing constantly about eighty men in several barges. The amount of sand taken from this harbour was estimated in 1836 at about 100,000 tons per annum,* a large proportion of which was transported into the interior from Wade Bridge by the Bodmin railway, and its branch, up the Camel, to Wineford. Notwithstanding the constant addition of sand thrown by the sea upon the Dunbar, this large demand appears to cause its decrease; and we were assured by competent persons that it had lost from 6 to 8 feet in height within the last half century. Independently of the sand conveyed inland by means of the river, large quantities of sand are also taken away, by means of carts, horses, and donkeys, from the sand-hills opposite Padstow.

Sand for agricultural purposes is also obtained in numerous bays and creeks on the north coast of Cornwall from Trevoze Head to the Land's End, and is esteemed in proportion to the shelly matter it contains. Of the few places whence sand is carried on the south of Cornwall, that from Falmouth harbour, composed of little else than corals, shells, and their fragments, is most esteemed. If we consider that Padstow harbour furnishes one-fourth of the sand employed for agricultural purposes in Cornwall and Devon, and estimate the ton as containing about 14 cubic feet, we should have 5,600,000 cubic feet of sand, chiefly composed of comminuted sea-shells, annually conveyed from the coast, and spread over the land in the interior as mineral manure. If we take the produce of Padstow harbour as only a fifth, then we should have 7,000,000 cubic feet thus distributed.

As may be readily conceived, numerous local causes tend to diminish or increase the value of the sands along the coast; generally speaking, the harder the coast and the less the detritus that can be worn from it, the greater the proportion of the comminuted shells in a given portion of sand. The easier also the streams or rivers flowing towards the shelly sands can deposit the sandy detritus they may bring down in floods before they reach the shelly banks, the finer the sand. We have found the sands, considered worth removal for agricultural purposes, to vary from 40 to 70 per cent. in their calcareous contents. Dr. Paris states that the samples of sand usually employed, and which he examined, contained from 60 to 64 per cent. of carbonate of lime. Probably this may be taken as a fair average proportion. The

* According to Mr. Worgan, the quantity of sand taken from Padstow harbour, in 1811, was 54,000 cartloads. Probably the facility afforded by the Wade Bridge and Bodmin railway may have considerably increased the consumption of this mineral manure, independently of the general improvement in the agriculture of the country, within twenty-five years.

same author suggests that, though unquestionably the beneficial effects of this mineral manure depend on the presence of the calcareous matter, the sea salt with which it is impregnated contributes materially to its fertilizing powers; citing as a fact, bearing strongly in favour of this opinion, that the farmers send several miles to the harbour of Padstow for the sand* which is drifted close to them.† The farmers certainly seem to prefer the sand which the tide has just left, and which must consequently contain much saline matter. It often also then contains fragments of sea-weed, and occasionally fresh animal matter derived from dead marine creatures, among which are the tenants of microscopic shells still little decomposed in them.

V.—*Observations on the Wheat-midge.* By the Rev. J. S. HENSLOW, Professor of Botany in the University of Cambridge, and Rector of Hitcham.

THE contribution which I now offer towards elucidating the history of the wheat-midge is so very slight, that I should scarcely have ventured to forward it to any other publication than a journal expressly devoted to the progress of agriculture. It is chiefly with the hope of stimulating others to co-operate in observing the habits of this little pest that I have determined to do so. I have been disappointed in not ascertaining the precise circumstances under which the larvæ of this gnat pass to the state of pupæ, and these again to the fly state. Until these circumstances are explained, we cannot feel perfectly sure that any proposed palliative against their attacks is likely to be of essential service. I shall detail the observations and experiments which I have made since last year; and if they have no further benefit than showing the possible extent of damage which this insect is likely to produce in seasons favourable to its increase, an effort will have been made towards provoking practical men to a more attentive study of its habits.

* The writer of this note was informed by a gentleman at Padstow that the freshest sand of that harbour contained more than 80 per cent. of carbonate of lime. It would be very important to know in what proportion the alkaline and earthy muriates and sulphates known to exist in sea-water are contained in this sand, as there can be no doubt that the value of this sand as a manure depends almost entirely upon its saline contents, which may be applied to land where the sand cannot be obtained. They constitute, in fact, an essential part of all perfect manures.—F. FALKNER.

† Trans. Geol. Society of Cornwall, p. 194. Borlase has observed that the salter the sand the better it was for agricultural purposes.—(Nat. Hist. Cornwall, p. 82.) “Blown sand,” he says, “which has been long exposed to the air, is good for little, its salts are so wasted by wind and rain.”—(Ib. 83.)

Former observers have noticed the fact, that some of the larvæ (or maggots) quit the ears in which they have been feeding in order to bury in the ground, where it is supposed they remain until they change to flies; whilst other larvæ remain in the ears, and prepare for themselves a little case or covering in which they pass the winter. This case looks very much like an outer skin, as though the larvæ had contracted itself, and become detached from its skin without shedding it; and upon this case all the markings of the body are impressed. The exact nature of this case I must leave it to entomologists to decide; but of the fact here alluded to I have had ample confirmation.

In my report last year I offered a conjecture, that those larvæ which entered the ground had been "ichneumonized," whilst those which remained encased and in the ears would be found uninjured, and would turn to flies in the spring. I have carefully preserved specimens of each kind: those which spontaneously quitted the ears were allowed to bury themselves in sand; and those which remained in the ears were kept apart. I collected some hundreds of the latter description from the barns in the neighbourhood, in a manner I shall presently describe. Not one of either batch have changed to flies, or even produced me any specimens of the little ichneumon which plays so kind a part in diminishing the numbers of the midge. Mr. Curtis, to whom I forwarded specimens, has been equally unsuccessful with myself. In a letter from him, dated the 30th of June, I find the following remarks:—"I took infinite pains in nursing the different ears of wheat in which the *Cecidomyia* larvæ were, and at present they have produced nothing. I have not been able to ascertain the state of mine, but if yours be juicy, they will no doubt produce either the midge or a parasite in due time. I think it very possible that different things may have been confounded, for with the greatest care I find myself often perplexed by the appearance of some unexpected insect, where a totally different one was expected. Your *Cecidomyiæ* may be retarded by being unassisted by heat or wet, as in nature; or they may be all females; or another species; but I do not despair of your breeding them." This account will be sufficient to show practical men the great difficulty which frequently attends the elucidation of some questions in natural history.

I proceed now to detail the observations I have made on those larvæ which remained encased and in the ears; and if it should hereafter be ascertained that these do assume the fly state, I think an easy method may be contrived for considerably diminishing their numbers.

I had selected ears of wheat from several fields in this parish shortly before the harvest of last year. Upon picking them to pieces about a month afterwards, I found that every field from

which I had obtained specimens had been attacked by the midge : indeed some larvæ were present in almost every ear, and many of them were encased in the manner already alluded to. I was particularly struck with their abundance in some ears of a tall description of revets. In one well-grown ear I found only nine sound grains, all the rest having been reduced to an abortive state by the insect. The farmer to whom the wheat belonged assured me that he was never so much disappointed in a crop before. It appeared to thrive well, and looked fine, but the yield was at least one-third less than he had expected it would have been. Part of the deficiency might have been owing to the rust or red-rug with which the chaff and leaves had been attacked ; but from what I saw of the effects produced by the midge, I was satisfied that the mischief was chiefly owing to this insect. I next ascertained that numbers of the larvæ might be found on the floor of the barn where the wheat was threshed ; and next, when the wheat was dressed, I found that some of the larvæ fell through the wire-gauze together with the dross, but that the greatest number were blown out with the chaff. Upon sifting the chaff through the sieve usually employed to clean it for the cattle, all the larvæ which have been blown from the machine pass through with the dust. In order to form something like a definite notion of the numbers of the larvæ which are housed with the wheat, I endeavoured to ascertain the number which might be picked from a certain measure of this chaff-dust, and thence to calculate the numbers contained in a bushel of it. Those larvæ which were encased and appeared full grown, and ready to turn to pupæ, I numbered apart from those which were imperfect, and many of which were dead. The following table will show the result of this inquiry ; and I shall make a few remarks upon the inferences we may deduce from it :—

Estimated for One Bushel.	Encased Larvæ.	Imperfect and Dead Larvæ.	Total.
J. PILGRIM.			
No. 1. Chaff-dust obtained at various distances from the machine	21,768	148,608	173,376
— 2. Dust obtained by sifting the dross-wheat			
	22,752	108,864	131,616
J. HARPER.			
— 3. Chaff-dust close to the machine	29,088	48,672	77,760
— 4. Ditto at 1 yard from the same	18,144	18,720	36,864
— 5. Ditto at 2 yards	1,440	6,376	7,816
— 6. Ditto at 3 yards . . . . .	..	576	576
JOS. BARTON.			
— 7. Chaff-dust from a heap of chaff swept together from the whole floor	125,856	281,088	406,944

Nos. 1 and 2.—These were obtained at the same time, and show that more are contained in a bushel of the dust from the chaff than in that from the dross. As there must be many more bushels of the former than of the latter, it proves that a very great majority of the larvæ are blown out with the chaff. Had the chaff been selected from near the machine only, the difference would have appeared more striking.

Nos. 3 to 6.—Obtained at another barn, clearly show that the majority of the larvæ fall within about a yard of the machine, and that it would be unnecessary to sift the chaff which falls beyond 3 yards in order to obtain them.

No. 7.—Obtained from a third barn, abounded with the midge to a much greater extent than the former samples. But this sample was searched more carefully than the others, with the aid of a pocket lens, which may partly account for the very large number detected. I do not know how many bushels of dust might have been obtained by sifting the chaff of a whole harvesting, on any one of these farms, but was informed that it would have amounted to several. The usual practice is to throw this dust aside, either upon the floor of the stable or on the muck in the yard; and it is supposed that any insects or seeds it may contain will be destroyed by the process of fermentation. It is very possible that many are destroyed in this way, but I do not doubt that vast numbers must escape. I have therefore suggested the propriety of always burning this dust, as not only affording a ready means of destroying these and other insects, but also of getting rid of a number of minute seeds of weeds. A slight alteration in the regular routine of farm practice would be all that would be necessary; the chaff being sifted immediately after the dressing of the wheat, instead of at the time when it is given to the cattle. If it should hereafter appear that these encased larvæ never turn to the fly state, and consequently that the practice here proposed would be needless, I should still suggest the propriety of its being generally adopted; I have learnt within a very few days that it is constantly resorted to in one part of this country where the farming is of a superior character. The practice would doubtless be found useful in promoting that wholesome cleanliness from weeds which is so essential to the perfect success of all crops.

From some observations I made in the neighbourhood of St. Albans, I am inclined to think there are more species than one of these midges which infest the wheat; and that possibly different species may be limited to particular districts—I judge merely from some slight differences which struck me in the character of the larvæ obtained from thence. I have received the larvæ from the North of Ireland and from Shropshire, and have now found them

in Devonshire and Cornwall. These localities, together with those I mentioned in my report, leave us in no doubt of its very general distribution, and must satisfy every one of the importance of discovering, if possible, some effectual means of diminishing its injuries.

Hitcham, Suffolk, 19th Oct., 1841.

VI.—*On the Use of the Great or Jersey Trench-Plough, exhibited at the Society's Annual Meeting at Liverpool, in July, 1841.* By Colonel LE COUTEUR.

I SHOULD not have ventured to invite the attention of this great Society to the Jersey Trench-Plough had I not given much consideration to the subject, and observed that in many parts of England and Scotland, where the cultivation of root crops is so much practised, the crops are not so heavy as I consider they might be under an improved system.

I attribute, in a great measure, to the deep ploughing in Jersey the very heavy crops of potatoes, parsneps, carrots, and wheat that are raised; perhaps also the deep ploughing leads to the very large crops of hay and after-grasses that are grown there by ordinary farmers.

It is presumed to be correct to say that as nearly as farm husbandry can be assimilated to garden culture, ever keeping in mind the farm account, or working in the best manner at the least expense, the more likely are we to raise not only heavy but clean crops.

If this position be a correct one, it is absolutely necessary to call attention to the fact that the best market-gardeners, who are found in the vicinities of cities (take London and Paris, for instance), practise deep husbandry, or *trench* with the spade. If a man finds a shallow soil, he is seen to deepen it, not alone with his spade, but with a mattock or pickaxe.

I have seen beautiful celery, parsneps, carrots, and potatoes, raised on almost pure sand, with a little earth trenched in at bottom, and a good dressing of manure between the sand and the earth.

It is scarcely necessary to quote many authors in support of this opinion. I will merely bring to recollection that Mawe, Sinclair, Loudon, and other English writers, observe that "the merit of trenching in general is superior to plain digging for many principal crops, or any plantations, as with the top soil all weeds and dung are more effectually BURIED in the bottom, and

the fresh soil below more readily turned to the top, which is of considerable importance in the growth of all seeds and plants."

Sir John Sinclair states "that considerable tracts of waste lands have been rendered capable of regular cultivation by trenching."

The French writers, Du Rozier, Dombasle, Vilmorin, Noisette, speak in this sense, that digging is not simply the mere stirring of the earth with a spade, as is practised with inexperienced cultivators, or labourers more interested to display a large surface of work than careful to have performed it well. Masters often judge of work by its extent, hence it is easy to comprehend that in such cases labourers think of little else. In order to work the soil well, it must be turned to a depth proportionate to the length of the roots which are to grow in it, whether they be sown or planted; meaning, that if the roots are to be 6 inches long, the soil should be worked at least from 9 to 10 inches.

If these opinions of the best authorities in the most civilised countries are correct, the general working of soils for ordinary crops is not sufficiently deep throughout the united kingdom.

I am aware of the delicate ground on which I am stepping, of the prejudice which long practice, much consideration, and science itself has established—science, in one sense of the word, when compared with the dark state in which agriculture had remained up to the days of Tull and Sinclair, those parents of modern husbandry; but the most scientific farmers now admit that we are still infants in the knowledge of the soil—the chemistry of agriculture, unfolding its wonders under the mighty lights of Davy and Liebig. The botany and entomology of husbandry, revealed to us by Kirby, Bauer, Henslow, Lindley, and others, show us how much we have to unlearn, and how much more to learn!

A deeply reflecting mind may perceive that the intelligence and observation of acute persons, among men considered to be mere ordinary farmers, have led them to adopt nearly correct courses of husbandry, after, perhaps, a quarter of a century of reflection, including merely the experience of four rotations of a six-course shift, or six of one of four courses; in truth, a short experience to build a system on, which profound sagacity alone could even approach to establish. Under the light of science, correct rotations may now be followed with certainty, the analysis of a soil pointing out its wants and capabilities.

The trench-plough will only suit soils that are turned to the depth of 8 or 10 inches at least; and can be turned 18 inches or more. The object of proposing the use of this trenching-plough is twofold:—1st, To compress three or more ploughings and harrowings, spread over a whole fallowing season, into two ploughings and harrowings, hence effecting a saving of much labour,

and the use of the soil one season. 2ndly, 'To increase the weight of all the subsequent crops.

"The practice in many parts of England is," according to Loudon, "in usefulness and effect very different from what it ought to be. In most places the first furrow is not given until the spring, or even till the month of May or June; or if it is given earlier, the second is not given until after midsummer, and on the third the wheat is sown. Land may rest under this system of management; but to clean it from weeds, to pulverise it, or to give it the benefit of aëration and heat, is impossible."

The practice of the best farmers of the northern counties is very different. Loudon then describes what a proper fallow is:—"invariably commencing after harvest by one ploughing, as deep as the soil will admit, even though a little of the till or subsoil is brought up: this is the winter furrow." He afterwards describes four ploughings and harrowings, and the mode of collecting the couch and other weeds, with a view to destroy them.

In Professor Low's very excellent recent work, 'The Elements of Practical Agriculture,' at the article 'Fallowing,' "Five and in some cases six ploughings, with frequent harrowings and rollings, are to be given between the winter furrow and the month of August, when the dung is carried on the land and ploughed in." Here is a sixth or seventh ploughing, and lastly the seed furrow; in some cases eight ploughings, unquestionably an enormous expense, when added to the loss of the rent of the land one whole season.

The seeds, usually of wheat, are then sown, but it is added in the following page:—"This is precisely the management pursued in the case of turnips and similar fallow crops, so that when the learner comprehends the operations of the summer fallow thus far, he is acquainted with the manner of preparing the land for an extensive and important class of plants."

If by any process of husbandry the same result could be obtained from a culture for fallow or root crops of five or six months and only two ploughings, which is now obtained from this long operation of four to eight ploughings, spread over a period of ten months, it surely would be desirable and profitable.

No such thing as a fallow is known in Jersey, where from 112*l.* to 160*l.* is a common price for an acre. A farmer would be ruined if his land lay idle a whole season: the trench-plough is his sheet anchor.

An able writer in the 'Georgical Essays,' describing it in 1781, or thereabouts, observes, "It was first invented and practised by an intelligent farmer, about fifteen or twenty years ago. This plough, not yet sufficiently known, is of the greatest utility either for grubbing up the ground or ploughing deeply inwards,

either to establish nurseries or plantations. The inventor deserves everything from his country and from mankind. If he had lived in an age wherein merit and talents find protectors and encouragement, he would have received a reward for the invention of a plough which is, and ever will be, of universal utility."

In most cases, in the month of October or November, a skim-ploughing is given to an old or two years ley, which is left exposed to the winter frosts. It is well harrowed and cross-harrowed previous to carting out the manure, which is spread on the ground at a rate ranging between 12 and 20 tons per acre.

In some cases the above previous skim-ploughing is deferred till January or February, in order to allow cattle to feed off any herbage that may be left on the land, so that the two ploughings now to be described take place in the same month.

A short time (the shorter the better) previous to putting in the crop, the land receives its second, and generally last ploughing. The trench-plough then comes into play, preceded by its pioneer, the two-horse plough. A trench is opened through the middle or length of the field in this manner:—The two-horse plough is made to cast off a furrow up and down, so as to assist in forming the trench; the trench is then neatly sunk 18 inches deep, more or less, according to the depth of the soil, and squared off 2 feet wide with spades, the earth being thrown off to a distance on each side.

A man with a spade should then be placed at each end of the furrow, to dig and square it out half the length of the trench-plough, as wide as the furrow intended to be taken, in order to enable it to plunge into its depth at once on turning into work: this is made at the left-hand side of either furrow, after the small two-horse plough has made its start.

This two-horse plough (one that will take a width of furrow one inch wider than the trench-plough) then precedes, and turns in the manure and turf together with 3 inches of soil, into the bottom of the furrow or prepared trench. The trench-plough, drawn by four, six, or eight horses, according to the depth desired, then turns over from 10 to 18 inches of* clean soil on the turf, which is so completely buried as to destroy all vegetation, even in freshly broken sod. When the sod is quite fresh, as little soil as possible should be taken up by the small plough, so that the couch or weeds may be more completely covered by a great mass of clean soil. When the ploughed land becomes so wide as to render it inconvenient for one man at *each end* to open the furrow for the plough on one side, and square up the other side

* The ground must be of a rich nature, or the subsoil thus turned up would rather injure than improve any following crop.—F. BURKE.

neatly, one man is placed at *each corner* to perform this work, so that two additional men at each end of the land, or four in all, are now digging, levelling, and squaring up the corners.

Two acres or more may thus be turned in a day, as the trench-plough takes a wide furrow, from 11 to 13 inches, and by its excellent construction moves and turns the whole soil.

This operation is performed by joint-stock labour by all farmers in Jersey, who bring their teams to assist each other: it is appropriately denominated not a great ploughing, but a GREAT DIGGING, “une grande fouerie;” indeed, no spade-husbandry is so efficient, as most men in digging merely turn the second spit upon the under or trench slice, whereas the whole soil is shaken and broken by the trench-plough.

The late President of the Horticultural Society, Mr. Knight, thus expressed himself in writing to me in reply to a description of the mode of cultivating potatoes in Jersey:—“Your mode of culture appears admirable; much better than ours; and your great plough, where the soils are deep and rich, must be an excellent instrument, never used in England—I believe.”

This was no slight authority, since corroborated by every British cultivator to whom I have had occasion to exhibit its performance.

Loudon, in his ‘*Encyclopædia of Agriculture*,’ describes two trenching-ploughs: one, No. 2616, is called a mining or trenching plough; the other, 2624, Morton’s trenching-plough, with two bodies,—both of them quite unsuited for the culture here recommended, whatever their merits may be.

Ordinary ploughings and cross-ploughings are usually a furrow of 10 inches by 7: hence it is constantly the same soil that is moved, and, if for a long-rooted crop, not as the French writers recommend, to a depth of 3 or 4 inches below the root, but just sufficiently deep to stunt its growth.

I feel almost convinced that the long or round-rooted are the proper preparatory crops for wheat, and that wheat after a grass ley fallow is erroneous practice. I have never seen a very fine sample grown by such a course.

It appears to me that I am borne out in these conjectures (hazarded some years since) by the recent discoveries of Liebig; an admirable writer, whose profound researches may lead to great results. I am aware that much of his work may be called scientific, what is sometimes improperly said to be too deep for farmers, but it should be on every farmer’s table, were it only for the chapter ‘*The Art of Culture*,’ where he observes:—“There is no profession which can be compared in importance with that of agriculture, for to it belongs the production of food for man and animals: on it depends the welfare and development of the

whole human species, the riches of states, and all commerce. There is no other profession in which the application of correct principle is productive of more beneficial effects, or is of greater and more decided influence. Hence it appears quite unaccountable that we may vainly search for one leading principle in the writings of agriculturists and vegetable physiologists."

Further on: "It is the greatest possible mistake to suppose that the temporary diminution of fertility in a soil is owing to the loss of humus: it is the mere consequence of the *exhaustion* of the *alkalies*. For small as is the quantity of *alkali* which plants require, it is nevertheless quite *indispensable* for their perfect development. But when one or more years have elapsed without any alkalies having been extracted from the soil, a new harvest may be expected."

How may I practically apply this? Twenty years since an old experienced farmer observed to me:—"You do not use *vraic* (kelp-ashes); try them; put 2*l.* 5*s.* worth of ashes per acre on your land prepared for wheat, let it lie on the surface a month or two, and turn it in with your wheat; it will return you 3*l.* or 4*l.* profit, with a finer sample; it *makes grain*, or fills the ear well." The result has fully justified the prediction. It has been the constant practice in Jersey for a century past, and does precisely act as Liebig states. He observes, p. 152:—"Wheat will not grow on a soil which has produced wormwood, and, *vice versâ*, wormwood does not thrive where wheat has grown, because they are mutually prejudicial, by appropriating the alkalies of the soil." Again, p. 161:—"It was deduced from all the foregoing facts, that plants require for their growth different constituents of soil, and it was very soon perceived that *an alternation* of the plants cultivated maintained the fertility of a soil *quite as well* as leaving it at rest or fallow. It was evident that all plants must give back to the soil in which they grow different proportions of certain substances, which are capable of being used as food by a succeeding generation.

"Now as excrements cannot be assimilated by the plant which ejected them, the more of these matters which the soil contains, the more unfertile must it be for plants of the same species. These excrementitious matters may, however, still be capable of assimilation by another kind of plants, which would thus remove them from the soil, and render it again fertile for the first. And if the plants last grown also expel substances from their roots, which can be appropriated as food by the former, they will improve the soil in two ways. When we grow in the same soil for several years in succession different plants, the first of which leaves behind that which the second, and the second that which the third may require, the soil will be a fruitful one for all the three kinds of produce. If the first plant, for example, be wheat, which con-

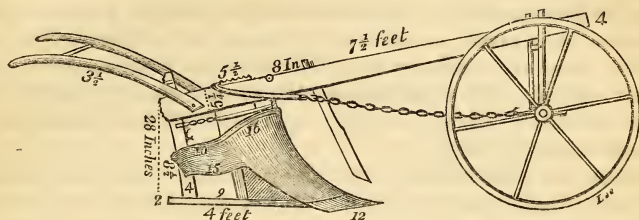
sumes the greatest part of the silicate of potash in a soil, whilst the plants which succeed it are of such a kind as require only small quantities of potash, as is the case with the Leguminosæ, turnips, potatoes, &c., the wheat may be again sowed with advantage after the fourth year; for, during the interval of three years, the soil will, by the action of the atmosphere, be rendered capable of again yielding silicate of potash in sufficient quantity for the young plants." This is precisely the Jersey practice.

It will be perceived that my anxiety is to prove that these scientific discoveries are in accordance with the soundest practice; that I imagine it to be dangerous to grow the grass family in succession, as, wheat on an old grass ley, to destroy the noxious excrementitious matter of which requires from five to seven ploughings, and a whole season of labour and waste of land; whereas, by the use of the Jersey trench-plough, those crops may be grown, which prepare the land well, and themselves furnish nutritive matter for wheat or barley. By the mode of culture described, from 13 to 14 tons per acre of potatoes are grown on all good soils in this island, though 16 is a frequent crop, and the same soils usually produce 30 bushels of wheat per acre in ordinary seasons; while in the best, they regularly produce 48 imperial bushels. I should recommend this system for all lands that can be ploughed from 9 inches to any greater depth—as a trench 9 inches deep, and of proportionate width, say 18 inches, would receive the turf and manure skimmed 3 inches, then be perfectly covered by 6 inches of clean soil, with the trench-plough and a pair of, or three, horses. Wherever the till or subsoil is new and uncultivated, only an inch or two of it should be brought up in a season and well top-dressed, by which means 2 or 4 inches of working soil might be gained in every four-course shift. When a failure in a crop takes place by the increase of depth of ploughing, it is usually from too suddenly bringing a large quantity of maiden soil to the surface, so that its acrid nature injures the young rootlets of the crop; whereas, if only a small portion be brought up and well intermixed with the old soil, which it would be most completely so by using the paddle-plough, it may merely act as a stimulant, and be beneficial. This is a condition to which the attention of experienced as well as young farmers is specially invited.

A very competent farmer in East Lothian* thus writes of the Jersey trench-plough, used by him last year for the first time:—"It is hard work for four horses ploughing 14 inches. I used six; they can work it without straining themselves 16 inches deep. Nothing can do its work better; it makes the best sole to a furrow I have ever seen. No person could know the land had

* I have permission to name that distinguished friend to agriculture the Marquis of Tweeddale.

been ploughed. My turnips are quite beautiful. I trench-ploughed one field in the dry weather, and reduced it with the clod-crusher to fine dust. No field has a better appearance, and quite before the regular turnip-land in the country."

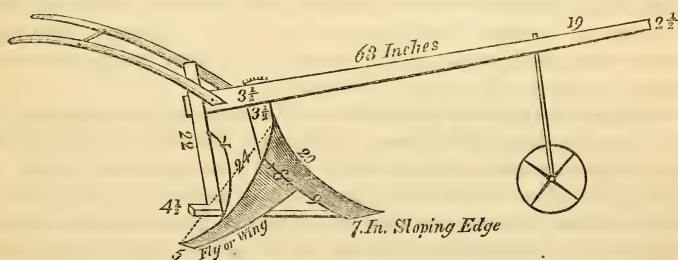


Large wheel, 42 inches diameter.
Small ditto, 38.

N.B.—When there is a coulter, which should take about 4 inches of earth, no earth falls back into the furrow, which is the case if no coulter is used. Boutillier's price for a great plough with coulter, chain, and wheels, with gallews complete is 6*l*.; extra strong, 7*l*. to 8*l*.

The Jersey Potatoe-setting Plough.

The fly or wing is moveable, and can be set to 16, 18, or 20 inches :—



After the land has been trench-ploughed, as described, a light harrow is passed over it; a cross-harrowing is given when necessary. The land is not cultivated in ridges; being generally self-drained, it is always levelled as nearly as possible. The potatoe-setting plough is then used. This plough was invented in 1834 or 1835, at the suggestion of the writer, by Le Boutillier, the smith who devised the paddle or potatoe-digging plough. It weighs about 60 lbs., and in light soils may be drawn by one horse, though more work is performed by using two.

In form it is a diminutive of the trench-plough, which suggested its use. It traces a furrow 5 inches wide at the desired depth, from 3 to 6 inches, regulated by the wheel, and the earth is carried off 18 or 20 inches to the right by the wing of the turn-

furrow, so as to fill the last-formed furrow, into which women or children, stationed at regulated distances, will have dropped the sets : thus no delay whatever takes place.

By the usual method there is much loss of time, as the setters have to wait till the plough has taken its second turn to cover the potatoes previously set. With this plough, half the time and much labour is thus saved, as the two operations are performed at once.

The usual after-culture is to horse-hoe the potatoes twice : once as they appear after a harrowing ; the second about a month later. The method of taking them up by Le Boutillier's paddle-prong plough is now added.

When the potatoes are ripe, the tops and large weeds should be drawn from them, or cut off, and removed from the field, or conveniently placed in rows. Some farmers then harrow the surface to level it, if the potatoes are sufficiently deep not to be disturbed by the harrowing.

A straight-edged furrow should then be opened at each side of a field or piece of land to be dug, so as to enable the revolving prongs of this plough to turn freely sideways at once, then the plough, drawn by three horses, if the land is heavy, if light, two, should proceed round the field as many turns as the width of a harrow. It throws out the potatoes sideways by means of the revolving prongs. The horses must then be taken from the plough and hooked on to the harrow, which should take one turn, in order to uncover any potatoes which the prongs may have caused the earth to cover in revolving. The horses are again tacked to the paddle-plough, and so on.

Women or children placed at such convenient distances as not to delay the plough or harrow, will have picked up all the small weeds and potatoes, and thrown them into separate heaps, and the work will proceed at the rate of two acres in a day, with a driver, three horses, and twelve pickers. The drier the weather and land is, the better will be the work. The land remains finely comminuted and levelled.

My own practice is, as soon as the crop is off the ground, to spread lime, or ashes, or soot on the land, and give it a second rather deeper ploughing with the paddle-plough, in order to mix them intimately with the soil, and to collect the potatoes that may have remained after the first ploughing.

Fewer potatoes are bruised, cut, or smashed by the revolving prongs, than by men lifting them with forks. Care must be taken that the ploughshare is sufficiently below the potatoes to lift them fairly, so as to be caught by the revolution of the prongs.

If the horses are driven on the land, three in a line, not a potatoe will be injured by them.

J. LE COUTEUR.

VII.—*Observations on the Natural History and Economy of various Insects affecting the Turnip-Crops; including the Plant-Lice, Maggots of Flies, Caterpillars of Moths, &c.*
 By JOHN CURTIS, F.L.S., Corresponding Member of the Imperial and Royal Georgofili Society of Florence, &c.

PAPER III.

HAVING detailed the economy and natural history of two of the most formidable enemies to the turnip-crops, I shall proceed to the investigation of some others which attack the foliage, and leave for a future report those which assail the roots. Some of them may at first appear to be of little consequence, as affecting the property of the farmer; but as we know that it is only from the excess of insects that serious mischief arises, and as it is far from improbable that they may all have their destined periods of appearance, to ravage our crops with fearful force, none of them ought to be neglected: for these reasons it will be advisable to make all the insects connected with farming known to the agriculturist; and I hope that the thirst for knowledge which is so natural to man will tend to render my investigations acceptable. Let it likewise ever be borne in mind that whatever God has created is deserving of our attention, and the more we study his works the more convinced shall we be of the wisdom they manifest.

HISTORY OF THE APHIDES, OR PLANT-LICE.

There is no tribe of insects so universally distributed, or exceeding in multitudes the plant-lice; and, of all the animals that are destined to torment the gardener, none are more successful than the Aphides, and the agriculturist not unfrequently suffers from the effects of their blighting powers, for probably there is not a plant, from the smallest grass to the most stately tree, that is altogether exempt from the visits of this pigmy:—

“Feeble race! yet oft
 The sacred sons of vengeance, on whose course
 Corrosive famine waits, and kills the year.”

The immortal Linnæus, considering that every plant supported a distinct species of Aphis, named these insects after the vegetables they fed upon; and similar as they may appear to a careless observer, I am induced, from an extensive and careful examination of this subject, to subscribe generally to the opinion of the Swedish naturalist: indeed, as far as the turnip is concerned, there are three, if not four, species of plant-lice that are attached to the different varieties of this invaluable crop—two or three living upon the leaves, the other infesting the flower-stalks of

those left for seed: one is exceedingly like those which attack the cabbages,* and I believe they are identical: if such be the case, it may be admitted as an exception to a general rule, but it must be remembered that it is the swedes which this species infests.

We have in a former report alluded to the remarkable economy of the Aphides, which during the summer bring forth young without sexual intercourse, and in the autumn lay eggs; the fecundation of the first female being sufficient to render twenty successive generations fertile.† No writer that I am aware of has paid particular attention to the turnip-aphides, although the leaves are often infested to a great extent towards the end of summer, as well as in the autumn, and by their piercing the nerves the leaves become curled and distorted, at the same time affording the insects a habitation, protected both from heat, wet, and cold: the green tops thus become less serviceable as food for cattle, and the growth of the roots is unquestionably retarded by the exhaustion of the leaves, and the outer ones, turning yellow, fall off. They are sometimes attacked at a much earlier period; for Mr. Marshall observed the Aphides extremely numerous on *seedling* leaves, from whence he concludes that they may be the cause of the very slow progress which is sometimes made by the young turnip-plants to push into *rough-leaf*.

I wished to watch the economy of these insects, and having sown some turnip-seed in a garden in the spring, I found the leaves infested with the Aphides in the middle of July, when the wingless females (fig. 2) were surrounded by their young broods, unmolested by the heavy rains which had incessantly fallen during the previous fortnight; and two winged ones were sheltered in the same situation (fig. 1). On the underside of one small leaf I counted 168 Aphides; they comprised about a dozen large green ones, like fig. 2, one of which was just giving birth to a young Aphis (fig. 3); apparently, to me, it was enclosed in a thin membrane, and came forth backwards, which would render its inclusion in a sac the more necessary; it was exactly like a pupa, with two little black eyes shining through, and the antennæ were folded backward, as well as the legs, so that the limbs were not free, but the instant it was perfectly excluded it began to move its horns, and immediately afterwards used its legs.‡ The females are green

* Mr. F. Walker says, "Two distinct species infest the turnip; the one is bright pale-red in colour, the other green, covered with white down, which is also abundant on the cabbage."—Vide 'The Entomologist,' p. 173.

† M. Bonnet, who first tried the experiment, thinks that Aphides would produce in this way to the thirtieth generation. ↗

‡ Mr. W. Curtis says that the young of *A. salicis* were able to use their legs before they were perfectly disengaged from their mother, and thus assisted in liberating themselves.—Linn. Trans., vol. vi. p. 79.

and finely shagreened ; most of them were surrounded by eight or ten young ones, of a yellower colour, and there was a considerable number of larger young ones, of a somewhat rosy tint. I likewise observed eight dark specimens (fig. 4), each of which was accompanied by five or six young ones, of a similar colour, with two dark oval spots upon the head ; and these, I am inclined to believe, belonged to a different species.

It may readily be conceived that, under favourable conditions of the atmosphere, the multiplication of the Aphides must be beyond calculation : in 1827 and 1836 they are stated to have committed very extensive ravages on the turnip-crops.* In the absence, however, of any positive data immediately connected with the natural history of the turnip-aphides, I shall avail myself of information relating to kindred species, which will equally well illustrate the habits and economy of this family, and supply us with the means of studying any of its members.† Most of the plant-lice, I believe, come forth in the spring, as soon as the foliage is apparent, but some are seen even before the leaves are expanded : at this time they are all wingless females, which have hatched from eggs that had been laid the foregoing autumn : these soon disperse, and forcing their rostrums up to the base in the tender stalks and leaves of plants, begin to produce young in ten or twelve days, which likewise seem to be wingless females ; and as no males make their appearance until the autumn, when pairing takes place, it is evident that the females must be pregnant at their birth, without sexual intercourse ; and this occurs for several successive generations. The females produce about two young ones daily during fifteen or twenty days ;‡ and Kollar says that, in ten days, the third generation from the eggs is able to bring forth young, comprising winged as well as wingless females, the former flying away as soon as they have arrived at maturity, and the latter remaining on the plant where they were produced. Both the winged and wingless females of the third generation are able to produce young in eight, and even in four days, which are capable of the same power as their parent at the expiration of a similar space of time ; and proceeding thus until the middle of September, the generations often amount to sixteen or twenty—thus, from one egg only, 729,000,000 of Aphides would be produced in seven generations, taking thirty as the average of each brood—twenty being the minimum, and forty the

* In 1793 the Aphides were the chief, and in 1798 the sole cause of the failure of the crops of hops.—W. Curtis, Linn. Trans., vol. vi. p. 79.

† Schmidberger, in Kollar's Naturgeschichte der schaedlichen Insecten : vide *Aphis pyri, mali, pruni*, and *persice*, p. 291.

‡ On opening the body of a willow-aphis, Mr. W. Curtis counted 61 young ones, large and small, and in another 46.

maximum ;* so that if they all lived, everything on the face of the earth would be covered with them. About the middle of September, the last generation, consisting of males and females, is produced ; the former generally becoming winged. When they have attained maturity, the sexes pair, and the females no longer bring forth young, but lay eggs, which are able to resist the severity of winter, and these, hatching in the succeeding spring, again produce viviparous mothers. The autumnal stock, having provided for the continuation of its race in the following year, generally dies off before the approach of winter.

Towards the end of March, or the beginning of April, we often have a succession of cold drying winds from the north and north-east, at which time the Aphides occasionally make their appearance so suddenly as to be termed a blight : these must be the offspring of the autumnal eggs, or broods which had lived through the winter. Their increase in damp and sultry weather, at a more advanced period, is equally surprising ; and the universal diffusion of such myriads soon after a thunder-storm has led, as with the black caterpillars, to the vulgar error of their having fallen from the clouds. Electricity probably causes the simultaneous appearance of insects in many instances, for the irritability of the nervous system is excited by the increased action of oxygen, so that insects, both in the egg and pupa states, may be more speedily developed, the dormant eggs may thus be called instantly into life, and the viviparous aphides bring forth their young simultaneously ; which may in some measure account for the vast swarms of plant-lice that so frequently cover, in a few hours, the flowers in our gardens and the crops in our fields.

I have already stated that there are three, if not four, species of Aphides which live upon the turnips : the first (figs. 1 and 2) I have found under the rough leaves of the English varieties, as well as one which I believed to be distinct (fig. 4) ; another (figs. 5 and 6) appears to be attached to the swedes ; and the last (figs. 7 and 8) is secreted amongst the flower-stalks. During the first few generations they are all wingless, but as the summer advances they appear to arrive at greater perfection, and assume a more complete state of development, so that eventually individuals of both sexes are furnished with wings, when they are capable of doing incredible mischief by the extended field of their operations ; for, flying about, they form colonies in every direction, and they are thus enabled to select a proper nidus for the eggs, which are laid by the last generation in the autumn, after

* Reaumur (vol. vi. p. 566) has proved that, in five generations, one aphid may be the progenitor of 5,904,900,000 descendants ; and it is supposed that, in one year, there may be twenty generations.—Vide Kirby and Spence's *Introd. to Ent.*, vol. i. p. 174.

the pairing of the sexes. The Aphides generally deposit their eggs, which are hard, and like parchment, in the most secure places, under the buds, in the forks of branches of trees, &c., and sometimes, it appears, upon the leaves.*

The young are furnished with horns and legs, like their parents, but they are generally narrower in proportion, and often of a different colour. Like most insects in their growing state, they change their skins several times, which are left sticking to the plants on which they live; and they are never deprived, from their birth to their adult state, of the power of locomotion, as the turnip-beetles and turnip-saw-flies are, which lie quiescent in their pupa state. The Aphides belong also to an ORDER which we have not before noticed, called HOMOPTERA, but it formed a section only of Linnæus's order *Hemiptera*: the FAMILY is named APHIDIDÆ, containing, amongst other groups, an extensive GENUS called APHIS.

This genus † has two horns (fig. 11), considerably longer than the body, often as long as the wings, naked and tapering like bristles, inserted in front of the face, composed of seven joints, of which the two first are short and oblong, the following long, especially the third. Rostrum bent under the breast, short, and four-jointed, longest in the females (fig. 9 *h*). Eyes globose and lateral (9 *i*); ocelli, or simple eyes, three, very remote (9 *k*). Collar of thorax very long in the males. Abdomen ovate-conical in the males, with two tubes on the fifth segment. Wings four, transparent, deflexed in repose; superior twice as long as the body, ample, with several nervures, the furcate apical cells short: inferior wings much smaller, with a nervure forming three rays. Females generally apterous; the bodies stouter. Legs six (fig. 12), long and slender, especially the hinder pair: thighs long (12 *l*); shanks longer (*m*); feet short, composed of two joints, the first scarcely visible (*n*), terminated by two curved acute claws (*o*).

The different species already alluded to I will now proceed to describe:—

1. *Aphis Rapæ*, Curtis ‡—the Turnip-leaf plant-louse.

Male—ochraceous; horns moderately long, setaceous, fuscous, two first joints black, third ochraceous at the base: head blackish, collar ochraceous and brown, disc of thorax shining black; abdomen greenish, the spiracles or breathing pores brown: tubes long, slender, ochraceous at the tip; the apical process of the body

* Mr. W. Curtis saw several small irregular groups of eggs of an *Aphis* which were deposited on both sides of the leaves of some *Auricula* plants, in November.

† Curtis's *British Entomology*, fol. and pl. 577.

‡ Curtis's *Guide to an Arrangement of Brit. Ins.*, Genus 1047, 18 *b*.

ochraceous also: wings iridescent, the nervures light brown: stigmatic spot long and yellowish; apical cell somewhat oval; furcate cells elongate-trigonal; terminal one short: tips of thighs, shanks, feet, and claws, black (fig. 1). *Female*—bright green, shagreened: horns fuscous, except at the base: eyes, tips of shanks, and feet, black (fig. 2).

Abundant beneath the leaves of the English turnip the whole of July, &c. It is at once distinguished from the other species by its long tubes and small apical cells of the wings.

2. *Aphis dubia*, *Curtis*—the Black-spotted turnip-leaf plant-louse.

Female?—dull darkish green, shagreened: antennæ shortish, third joint ochraceous, the following fuscous: rostrum short and stout: eyes, ocelli, and two large patches on the collar, black: each segment of the abdomen has a more or less complete transverse black stripe, interrupted down the middle; the tubes are slender and longish, the tail is banded with black, and the conical apex is of the same colour (fig. 4).

Found, the end of July, beneath the turnip-leaves, with the former species.

3. *Aphis Brassicæ*, *Linnaeus*—the Cabbage and Swedish-turnip-leaf plant-louse.

Male—generally pea-green: horns setaceous, longish, and black; as well as the head, collar, and disc of thorax: several blackish bands, more or less perfect, across the body: tubes short and stoutish, black at the base: wings iridescent, stigma pale-green, nervures strong, piceous, apical cell large, and the first furcate one wider than in *A. rapæ*: legs black, base of thighs green (fig. 5). *Female*—slightly mealy, generally of a yellower green than the males: third joint of antennæ ochraceous, following black: eyes, two large spots on the crown, and one on each side of the collar, black: abdomen very large and heavy: spiracles, several dots upon the back, and a few transverse streaks beyond the middle, black: tubes short and black, as well as the legs; base of thighs, greenish (fig. 6).

As far as my own observation goes, the swedes have suffered most from the Aphides; the under-sides of the curled leaves being sometimes densely covered with them, of all sizes. The old wingless females are seen resting, in August, September, and October, surrounded by their young broods, with here and there a winged male walking lazily over his kindred. The leaves are frequently at the same time grey with mildew; but that is a distinct disease.* I may observe that I have seen myriads of *Aphis*

* It is said that, in a very dry autumn, early-sown turnips seldom escape the mildew, which is a species of fungus, forming a whitish powder over the leaves, and readily brushing off: the leaves thus affected soon become

brassicæ under cabbage-leaves in July, and secreted in the leaves of the crumpled broccoli as late as the end of November, when they were of all ages and sizes, both winged and apterous.

4. *Aphis Floris-rapæ*, *Curtis*—the Turnip-flower plant-louse.

Male—dull pale-green, dusted with white: antennæ moderately long, blackish, excepting the base of the third joint: eyes, head, disc of the thorax, and abdomen, varied with black; tubes short and barrel-shaped: wings similar to those of *A. brassicæ*: legs ochraceous; apex of thighs, shanks, and feet, black (fig. 7).

Female—dull pale pea-green, powdered with white: rostrum short and stout: eyes black; antennæ rather short, slightly hairy, terminal-half brownish: abdomen, with the spiracles, and several dots forming two rows towards the apex, black; tubes short, oval, and black; legs clothed with short hairs; the feet black (fig. 8). I regret having to draw my description and figure of the male from dead specimens; for the colours, as well as the form of the body, have changed considerably.

Towards the end of July I found a multitude of these Aphides secreted amongst the short flower-stalks of the early white turnip, when a few only of the flowers were open. They were of various sizes, but all apterous at that period; by the middle of August, however, they had increased to very large companies, with a few winged specimens. This species is readily distinguished by its white dusty appearance, with which both sexes are thinly coated, as well as by their short, conical, and black tubes, or ducts: the black spots on the backs of some females were larger, and the horns longer, than in the individual represented in the plate.

Whether any of the above Aphides deposit the sweet liquor called honey-dew upon the turnip-leaves has not yet been observed; but I have never seen the ants occupied in visiting the infested leaves for the purpose of collecting the saccharine matter which exudes from the two abdominal tubes or ducts, and which is also discharged from the extremity of the bodies of some species.*

Protected as the Aphides are in the wrinkles of the leaves, which they themselves have caused by the pumping up and extravasation of the sap, it is, I think, impossible in the open field to apply any effectual remedy for the extirpation of this prolific tribe: when it is in our power, the best plan would be to cut off

yellow, dry, and brittle; and at an early stage this disease seems to encourage the Aphides, owing to the plants not being healthy and able to resist such attacks.

* The exudation of this honey, which passes off through the tubes, and chrysalises in cold weather, may be a necessary means of disposing of any surplus secretions arising from the constant supply of sap which is passing through the stomachs of these little leeches, and which they may not have the power of discharging fast enough by the usual organs.

the diseased leaves as soon as the presence of the insects is detected, and crush them completely under foot, or put them into a sack and carry them away to be destroyed with boiling-water. Watering the plants with equal parts of tobacco-water and lime-water is said to be the best mode of destroying the Aphides in gardens; and if plants be washed with tobacco-water alone—about half a pound of tobacco to a gallon of hot water—it will kill the Aphides; and if applied warm it will kill them the sooner. Strewing tobacco on hot cinders will soon rid a greenhouse of this pest; and sprinkling tobacco-dust upon trees when the dew is upon the leaves is an infallible remedy: but these applications would avail but little in the field even if it were practicable to employ them. Sprinkling of lime-dust is likewise considered a very effective cure, but not in wet weather, when the lime not only loses its caustic quality, but the Aphides so perfectly secrete themselves, that it is impossible to annoy them: I have been astonished to see plants swarming with them on the first dry day after long-continued and very heavy rains.

Fortunately, no tribe of insects has a greater number of natural enemies to keep it in check than the plant-lice; for besides swallows, robins, and numerous insectivorous birds, various bugs, spiders, beetles, and wasps destroy vast quantities; but the larvæ of the lady-birds, of the bee-like syrphus, of the golden-eyed flies, and several minute ichneumons, are pre-eminently useful, and particularly deserving of our attention: so much so, that on the continent gardeners collect the larvæ of the lady-birds and syrphidæ, and put them upon their rose-trees, &c.; for as they subsist entirely upon Aphides, they soon clear a plant of these troublesome and offensive little pests. I shall now endeavour to make the agriculturist better acquainted with the instruments provided by Providence to subdue a tribe of insects, which, without such parasites, would, like the plagues of Egypt, cover the land.

One of the most conspicuous and efficient enemies are the *Coccinellæ*, of which about thirty different species have been noticed in England,* varying amongst themselves in colour and markings, to as great an extent as any of our domestic animals. These pretty beetles, called lady-birds and lady-cows, seem to be under the especial care of the Creator: for they have secured the affections and good feeling of our children, and are amongst the few insects which in this country we are taught in our infancy not to regard with disgust or horror. The same kindly feeling is extended to them in France, where they are almost held sacred, being called *vache à Dieu*, and *bêtes de la Vierge*, or “God’s cows,” and “the Virgin’s insects.” The lady-birds hybernate

* Curtis's Brit. Ent., fol. and pl. 208, and Guide Genus, 438.

and pass the winter in the crevices of palings and trunks of trees, under loose bark, in dry leaves, on the ground, &c., and are therefore ready, on the shortest notice, to come from their hiding places, from which they are allured even by the sunny days of December; and on the approach of spring are amongst our first vernal visitors, when the female lays her little eggs beneath leaves, close together, in clusters of about fifty: they are cylindrical, buff-coloured, and set on one end; from these, little sprawling larvæ soon issue, of a lead colour, gaily ornamented with orange or scarlet spots, and are soon spread over the leaves of trees, palings, grass in fields, indeed, everywhere in the vicinity of the plant-lice, to which they are much more formidable than their parents. Their method of attacking the Aphides is curious. I have seen one of the latter struggling whilst this little insect alligator threw his fore legs about it, and was greatly amused at the skill it exhibited: for, fearing that the Aphis might escape, it gradually slid along to the wings, which were closed, and immediately began to bite them, so that in a very short time they were rendered useless, being matted together: it then returned in triumph to the side of its helpless victim, and seizing the thorax firmly in its grasp, it ate into the side, coolly putting its hind leg over those of the Aphis, whose convulsive throbs annoyed its relentless enemy. These larvæ are full grown in about a fortnight or three weeks, when they are from a quarter to a third of an inch long and upwards; they are then slate-coloured and yellow, with numerous black spots and hairy tubercles down the back, intermixed with a few scarlet spots (fig. 13*). They soon retire to a leaf or some secure spot, and, attaching themselves by the tail, change to pupæ (fig. 14) of a shining black colour, with a row of orange spots down the back: thus they remain during another fortnight or three weeks, when the inmate bursts through her cell, and appears again a perfect lady-bird.

Attracted by the swarms of Aphides in the hop-gardens, they sometimes congregate in myriads; and having regaled themselves and deposited their eggs upon the plants, they wing their way in large companies, often to perish on our shores in the autumn,* or to disperse themselves over our turnip and corn fields, where we often see their scarlet jackets sparkling upon the bright green leaves. These beetles belong to the ORDER COLEOPTERA, and to the FAMILY COCCINELLIDÆ, and form the GENUS COCCINELLA of Linnæus. There are two species which seem from their numbers to be most beneficial to man.

5. *C. bipunctata*, Linn. The two-spotted lady-bird is convex

* In 1807, the shore at Brighton, and all the watering-places on the south coast, was literally covered with them. Kirby and Spence's Int. to Ent., vol. i. p. 258.

and black, excepting the scarlet wing-cases, and on the centre of each of them is a black dot; at the inside of the eyes there is a cream-coloured spot, and a larger one on each side of the thorax, with two minute dots uniting at the base, of the same colour (fig. 15). This insect is so variable in colour, and the individuals are so very dissimilar, that it is called *Coccinella dispar* by many authors, some specimens being black, with a large red patch on each shoulder, and a round spot of the same colour on each wing-case, with the margin only of the eyes and of the thorax whitish; and between these extreme varieties will be found every gradation from red to black: they are all about $2\frac{1}{2}$ lines long.

6. *C. septempunctata*, Linn. The seven-spotted lady-bird is larger, very convex, being hemispherical, black, with bright brick-red wing-cases, having a large black spot in the centre of the base, with three smaller dots on each, forming a triangle: there are two cream-coloured dots at the base of the head, and a large one at each of the anterior angles of the thorax (fig. 16). It is more than $3\frac{1}{2}$ lines long, and nearly 3 broad, and varies but little, the spots sometimes being smaller than in our figure, and rarely vanishing.

The next, perhaps, in importance amongst the parasites is a diminutive fly (fig. 18), which hovers about plants infested by the Aphides; and the female soon settling amongst them, begins to examine the herd with her vibrating horns, and having fixed on a female Aphis, which is not already punctured, she bends down the apex of her body, and pierces the insect with her ovipositor, which is invisible to the naked eye: she then proceeds to another, depositing a single egg in each, and thus daily inoculates a considerable number. As the Aphis imbibes the juice of the plant, the little maggot which has hatched in her body hourly increases in size, growing with her growth, until the exhausted Aphis dies, leaving its horny, shining, and inflated skin sticking by its rostrum and legs to the plant, looking like a little tawny pearl: the parasite then changes to a pupa, and, having completed its various transformations, it becomes a perfect fly in about eight days, and eats through the side of its cell, often leaving a round lid attached and open like a door (fig. 17).

These insects belong to the ORDER HYMENOPTERA, of the FAMILY ICHNEUMONIDES ADSCITI, and were described by Linnæus under the name of *Ichneumon aphidum*. The species I have bred from the turnip aphides is now described as

7. *Aphidius* (*Trionyx*) *Rapæ*, Curtis.* Antennæ shorter than the body, composed of fourteen joints, basal joint beneath, as well as the mouth, ochraceous; head and thorax shining black; abdo-

* Curtis's Brit. Ent., pl. 383, and the Guide Gen. 562 *b* and 547, where fifty-four British species of *Aphidii* are recorded, forming the subgenera *Praon*, *Ephedrus* *Toxares*, *Monoctonus*, *Trionyx*, and *Aphidius* of Haliday.

men spindle-shaped and pitchy in colour, attached to the trunk by a narrow ochraceous petiole; wings four, iridescent; superior, with a narrow fuscous stigma, from which issues beneath a short curved nervure, and there is a large elongate-trigonal cell at the base; legs, six, slender and bright ochreous, variegated with dark brown; length, $1\frac{1}{4}$ line; expanse of wings, $2\frac{1}{3}$ (fig. 18 q).

As there are many generations of these flies in a summer, it follows that they are most formidable enemies to the plant-lice; and Providence, watchful of all his works, and regarding in the smallest as well as the greatest that balance which preserves the order of the universe, to avert the total annihilation of the feeble Aphides, has provided numerous other parasitic flies to destroy the destroyers, and again keep them in check. The *Aphidii* are such constant attendants upon infested plants, that I scarcely ever notice any unaccompanied by the horny shells of the defunct plant-lice; and even in a green-house I have seen nearly as many of these parasites as there were of the Aphides.

It is impossible to advance a step in the natural history of insects without finding so much to interest and admire, that it is difficult to refrain from entering fully into the subject: fearing, however, that I may become tiresome to the general reader, I will allude as briefly as possible to the little flies which destroy the maggots of the full-fed *Aphidii*, glutted with the vitals of the plant-lice: they are all Hymenoptera; and whilst they fly about to reconnoitre the aphides, no sooner have they met with one that contains a maggot than they pierce the already indurated shell, and deposit an egg within: as soon as it hatches, it commences feeding upon the parasitic maggot, or more probably on the quiescent pupa; and instead of an *Aphidius*, one of the following insects bursts from its dark tomb, namely, *Ceraphron Carpenteri*, *Cyrtogaster vulgaris*,* and *Colax aphidii*.†

8. *Ceraphron* (*Megaspilus*) *Carpenteri*, *Curtis*.‡ Black, head and thorax pubescent; body shining; horns long in the male, and eleven-jointed, the joints hairy, and more or less serrated, excepting the two first and the last; simply clavate in the female; wings, four, with a large brown semiorbicular stigma on the superior, from which issues a short curved nervure, being the only one; legs pitch-colour, apex of thighs, the shanks and feet ochraceous; length, two-thirds of a line; expanse $1\frac{3}{4}$.

I have frequently bred this insect from aphides, containing, no doubt, the parasitic *Aphidii*.

9. *Cyrtogaster vulgaris*, *Walker*.§ *Female* with clavate black

* Also *Coruna clavata* of Walker, in Ent. Mag., vol. i. p. 380.

† Curtis's Brit. Ent., pl. and fol. 166.

‡ Curtis's Brit. Ent., fol. 249, and Guide Gen. 581, 7.

§ Ent. Mag. vol. i., p. 382; Curt. Guide Gen., 624, 1.

horns, composed of thirteen joints; head and thorax bright green, shagreened; abdomen short, ovate, pointed, very glossy bottle-green; wings nerveless, excepting a single nervure near the anterior margin of the superior, which forms a little clavate branch beyond the middle; legs pitch-colour, nearly 1 line long and 2 broad.

10. *Colax aphidii*, *Curtis*.* Horns pale brown, hairy, thirteen-jointed, apical joint lance-shaped; head and thorax shining bluish-green; abdomen more yellow-green, very glossy, depressed, clavate; wings similar to the last, but the button of the nervure is larger; legs ochraceous; hinder thighs brownish at the middle; length, $\frac{3}{4}$; expanse, $1\frac{3}{4}$ line.

Both the above insects belong to the FAMILY CHALCIDIDÆ. I have bred the last from the indurated skins of the aphides which had been infested by the Aphidii. When touched, this fly skips about.

It is not a little remarkable that some of the *Cynipidæ* or gall-flies, which form the "Oak-apples," "Robin's pincushions," &c., prey in the same way upon the plant-lice, leaving their horny skins sticking to the leaves on which they fed. Amongst them I shall describe two only from my own collection.

11. *Cynips quercus-inferus*? *Linnaeus*.† Pitch colour, shining; head and thorax rugose; horns and mouth bright rust-colour; the former composed of fourteen joints; wings iridescent, with the nervures pale reddish-brown, having an elongate-trigonal cell on the margin, with an indistinct minute arcolet at its inner angle; legs ochraceous; length, $1\frac{1}{2}$; expanse 3 lines.

This was bred from aphides by the late Mr. T. Carpenter.

12. *Cynips fulviceps*, *Curtis*.‡ Glossy black; horns longish; thirteen-jointed; fuscous, ochraceous at the base; head and legs bright ochraceous; wings iridescent; nervures bright brown; arcolet none; length, $\frac{1}{2}$; expanse, nearly 2 lines.

I have bred several of this pretty species from aphides; and Jurine has figured another in his "Hyménoptères" of the same habits, called by him *C. erythrocephalus*, pl. xii. gen. 40.

We will now return to the insects which destroy the aphides, amongst which are some larger species of hymenopterous flies, belonging to the FAMILY of CRABRONIDÆ, which it is necessary to notice and describe here. §

13. *Trypoxylon figulus*, *Linn.*:|| is shining black, clothed with

* Brit. Ent., pl. and fol. 166, and Guide Gen., 641.

† Curt. Guide Gen., 564, 14.

‡ Brit. Ent., pl. and fol. 688; Guide Gen., 564, 27.

§ Those who wish to identify these insects with greater certainty must consult the plates and descriptions referred to.

|| Curtis's Brit. Ent., fol. and pl. 652, and Guide Gen. 682, 1.

silky whitish pubescence ; the horns are short and thirteen-jointed in the males, twelve-jointed in the females ; the body is rather long, forming a club, being slender at the base, and the edges of four of the segments are hoary ; the four wings are dusky at their extremities ; and the brown nervures form six distinct cells in the superior : it varies in size from $\frac{1}{4}$ to $\frac{1}{2}$ an inch in length, and the wings expand from 5 to 8 lines, or nearly $\frac{3}{4}$ ths of an inch.

These insects are abundant upon old posts, palings, or out-houses, gates, barns, stable-doors, &c., in which they form burrows to deposit their eggs, from the middle of May to the end of summer : it appears that they collect masses of aphides, probably to feed their young, which also subsist upon dead spiders, carried into the nests by the parent flies.

14. *Pemphredon unicolor*, *Fab.** Black, shining, clothed with greyish hairs ; head large, nose silvery ; horns short, curved, thirteen-jointed in the males, twelve-jointed in the females ; head and thorax punctured ; body oval, pointed and attached to the trunk by a narrow neck ; wings, four ; iridescent but smoky, superior with eleven cells, formed by blackish nervures ; length $\frac{1}{4}$ of an inch ; expanse 5 lines.

This, as well as a larger species, called *Pemphredon lugubris* of Fabricius, may be seen during the summer months, carrying immense quantities of aphides into straws in thatch, and holes in wood, posts, &c., to feed their young maggots upon. The following species, and likewise an allied one, have similar habits.†

15. *Diodontus gracilis*, *Curtis.‡* Smaller and more slender than *Pemphredon*, to which it is nearly related, but is distinguished by its notched upper lip : it is black and shining ; the head and thorax are punctured ; lower part of face clothed with silvery hairs in the males ; the four feelers and a stripe outside of the jaws yellowish-white ; the body is elliptical and pointed, attached to the thorax by a short neck ; wings transparent ; nervures and stigma pitchy ; tips of thighs, base and tips of shanks and the feet ochraceous, excepting the hinder pair ; length $\frac{1}{4}$ of an inch ; expanse 4 lines.

16. *Psæn atratus*, *Panz.§* black, shining ; antennæ thirteen-jointed, curved in the female, rusty beneath, especially in the males ; face silvery with hairs ; head and thorax finely punctured ; body ovate, conical at the apex, attached by a short slender neck at the base ; wings four, transparent, beautifully iridescent, the

* *Curt. Brit. Ent.*, pl. and fol. 632, and *Kennedy in Lond. and Edinb. Phil. Mag.*, Jan. 1837, p. 18.

† *Diodontus corniger*, *Shuck.*, and *Phil. Mag.*, January, 1837, p. 17.

‡ *Curt. Brit. Ent.*, pl. and fol. 496, *Guide Gen.*, 685^b, 5.

§ *Curt. Brit. Ent.*, second edition, fol. and pl. 25, *Guide Gen.* 691, 2.

nervures and stigma blackish ; fore shanks and feet sometimes ochraceous ; length, $2\frac{1}{2}$ lines ; expanse $4\frac{3}{4}$.

Mr. A. Kennedy observed the males of this species flying about the thatch of a summer-house and the neighbouring shrubs, at Clapton, in thousands, the beginning of July, and the females became numerous about the 10th : they employed the open straws of the thatch to deposit their prey in, which amounted to a hundred aphides in a single straw, containing cells with partitions made apparently of the scrapings of the inside of the straw cemented together. The eggs deposited in them by the *Psen* are white and semitransparent, and are attached to the abdomen of an aphid near the bottom of a cell.* I bred these flies likewise from straws out of the roof of a summer-house at Bristol, the end of June.

We now come to a set of insects, which, like the lady-birds, begin to feed upon the aphides as soon as they escape from the egg, and from that time are constantly hunting after them, until they change to beautiful flies, one of which is called the Golden-eye. These larvæ are ferocious little animals (fig. 19*), named by the French "*lions des pucerons*," or plant-lice lions. Some clothe themselves, like Hercules, with the skins of their victims (fig. 19), and others with the green and delicate lichens which cover old paling, and the trunks and arms of trees, so that unless the larvæ move, it is impossible to detect them ; and thus, concealed from the prying search of the smaller birds, they lie in ambush for their prey : but when they are encamped upon a leaf, amongst the sluggish aphides, they seize them with their long and powerful jaws, and will devour the largest of them in half a minute. The food of this voracious larva, however, is not confined to the aphides ; for two which I found at the end of August, on being placed in a box, immediately attacked each other, the conqueror making a meal of his companion, and soon after sucking the contents out of a caterpillar three-fourths of an inch long, leaving only their skins. These larvæ vary considerably in colour, being whitish or fuscous, with brown or orange spots, some having the sides of their bodies furnished with sixteen fleshy tubercles, producing a spreading bunch of hairs : they have a pair of slender horns, two long stout curved jaws, and a pair of long slender-jointed feelers ; besides their six feet, the apex of the abdomen is prehensile, forming, as it were, a seventh foot, which has the power of adhering to very smooth substances. After feeding for fifteen or sixteen days, they spin a fine silken whitish cocoon (fig. 20), which is often clothed with the bits of lichen which formed a shield to the larvæ : they vary from the size of pearl barley to a

* Phil. Mag., Jan. 1837, p. 18.

small pea, and are attached to leaves of plants, &c.; in these they change to a pupa, and in about three weeks the flies come forth in summer; but the autumnal ones remain through the winter in that torpid state. The case, it may be observed, is not spun from the mouth, as the silk-worm forms its cocoon, but from the apex of the body, similar to spiders; and it is astonishing, considering the very ample wings of some of the flies, how they can possibly be arranged in so small a space as they occupy in their little cells.

The flies are not long-lived, and the female deposits her eggs in a very remarkable way, in order to protect them from the attacks of parasitic and other insects. They are placed in groups of ten or twelve, on various parts of the leaves, stalks, &c., and so much resemble vegetable productions, that they have been mistaken for the capsules or seed-vessels of some moss. It appears that the female being supplied with a glutinous fluid in the ovary, she places the apex of her body to the edge of a leaf, and lifting it up, draws out a transparent thread, not thicker than a hair, sometimes to the length of an inch, the egg forming a little oval club at the tip (fig. 22). I think it extremely probable that they are deposited while the female is on the wing by an undulating flight, which brings her at intervals in contact with the leaf or object beneath her; but I believe no one has detected this insect in the act of depositing the eggs.

The flies which we are alluding to are included in an ORDER called NEUROPTERA, of the FAMILY HEMEROBIDÆ, and constitute the Linnæan GENUS HEMEROBIUS, which is now divided into four genera,* two of which, CHRYSOPA† of Leach, and HEMEROBIUS,‡ are the groups which produce the larvæ whose history we have just given. The former genus contains ten or twelve British species of beautiful flies, generally green, and well known by their prominent, splendid eyes, whence they are called with us golden-eyes. They fly principally at night, and are heavy on the wing by day, so that they are easily caught; and on being touched they emit a most offensive odour. I will now describe the commonest species, which is named by Linnæus

17. *C. Perla*. It is a palish green; the horns are slender, as long as the body, and composed of numerous small joints; the eyes very prominent, golden-green; body moderately long; wings four, deflexed in repose, twice as long as the body, transparent but greenish, reflecting the most beautiful rose-colour and rich yellow, reticulated with innumerable hairy nervures, the transverse ones blackish near the base; legs six, very short and slender.

* Curt. Guide Gen. 739, 740, 740^b, and 741.

† Curt. Brit. Ent., fol. and pl. 520.

‡ Ibid., 202.

Male, 4 lines long, wings expanding $1\frac{1}{4}$ inch; female, $\frac{1}{2}$ an inch long, expanding nearly $1\frac{3}{4}$ inch. (Fig. 21.)

This species is common about hedges, fields, gardens, and orchards in June, July, and August. Last May I found one of the larvæ: its back was clad with lichen, the skins of caterpillars in fragments, and apparently its excrement: it spun a white silken cocoon of exceedingly fine texture the beginning of June, to the outside of which adhered the materials already mentioned; and in a week or ten days after, I found in the box a fine specimen of the golden-eyed fly, of such dimensions that it appeared incredible it should have been produced from so small a pupa. A white transparent case or shroud, like those of the May-flies, was lying by it, showing that it had emerged as a pseud-imago.*

The other genus still retains the appellation of *HEMEROBIUS*, and is more extensive, comprising, it is supposed, upwards of thirty species. Their economy appears to be precisely the same as that of *Chrysopa*; for a larva which I found the end of last September was feeding upon Aphides in company with the maggots of the *Syrphidæ*. It was of a bright yellow, with markings of a clear rust-colour: it was very active, continually moving its head from side to side, and eventually produced a species named by the late Dr. Leach.

18. *H. obscurus*. It is ochraceous; the horns are rather longer than the body, slender, hairy, composed of numerous globose joints; eyes very prominent; head and trunk with a brown stripe on each side; abdomen of the same colour: wings nearly twice as long as the body, very much deflexed when at rest, slightly tinged with fuscous, but with a beautiful blue and rose-colour; superior, with numerous pilose nervures dotted with dark brown, having two irregular waved transverse lines of a pale brown-colour beyond the middle; inferior wings of a lovely rose-colour, the margin alone iridescent and brownish: legs 6, and rather short: about 3 lines long, and expanding 8.

These insects frequent every hedgerow and plantation, and from thence they fly by night into fields, meadows, gardens, &c., and they are sometimes plentiful in turnip-fields. They are always very brisk and lively on the approach of a thunder-storm; but when caught, they lie with their wings closed and compressed, and their horns and legs drawn up, as if they were dead, some of them looking, in that inanimate state, like dead leaves.

We shall close this account of the insects which feed upon Aphides, by giving the history of the larvæ of several flies called *Syrphi*, which appear to be more numerous than the lady-birds

* A state between the Nympha and the perfect insect or Imago.

or the Aphis-lions, and, being very expert, they cause greater havoc amongst the plant-lice than probably any of those already recorded. The parent flies are so numerous, as to be in a great measure the cause, I believe, of the incessant vibration of the air or buzzing which we hear in the country in fine, still, sunny days in the summer and autumn months: they belong to an ORDER called DIPTERA and to the FAMILY SYRPHIDÆ, which is divided into several GENERA, and amongst them are *SCÆVA** and *CHEILOSIA*, containing upwards of fifty species:† the larvæ of these are found during the spring, summer, and autumn in company with those of the lady-birds: they are fat, fleshy maggots, sometimes green, at others yellow, variegated with orange; and their skins are so delicate, that the circulation of the fluids and the colour of the intestines are distinctly visible even to the naked eye. When the maggots first emerge from the egg, they are little inoffensive-looking creatures, scarcely visible, surrounded as they are by the indolent, helpless Aphides, with their bleached, cast-off skins scattered over the leaves; but as soon as their appetites call them into action, they thrust out their heads and necks like leeches, fasten upon the nearest Aphis, and holding it up in the air (fig. 23), they suck out the contents of their victim with evident satisfaction. In this way one hungry maggot will devour a hundred Aphides in an hour: when satiated, he draws himself up, and lying close to the leaf, he enjoys his repose. Having grown to his full size, he attaches his tail to a leaf, tree, wall, or other object, and becomes a horny pupa in his own indurated skin, which assumes the shape of a pear, of a dull colour (fig. 24). Amongst the parent flies the most conspicuous are *Scæva Pyrastræ*, *S. Ribesii*, *S. balteata*, and *Cheilosia scripta*, which I will characterise.

19. *S. Pyrastræ*, Linn. (fig. 25) is a large fly with two little black horns in front of its ochreous face, and two large copper-coloured eyes, nearly covering the whole head in the males, but not meeting on the crown in the females; the trunk and a lobe behind called the scutal are bottle-green, densely clothed with short, pale, velvety hairs; the body is similarly clothed, flat, of a good size and oval, deep black, with three long, yellowish spots on each side, curved, and nearly meeting on the back; the two last segments are edged with the same colour: it has only two wings, which are as clear as glass, but iridescent, with several fine brown nervures, forming long cells; just below their base, on each side, is a little clubbed process, of an ochraceous colour, called a poiser; the six legs are pale rust-colour, the thighs black

* Curtis's Brit. Ent. fol. and pl. 509.

† Curtis's Guide Genera, 1240 and 1241.

at the base, the hinder entirely black, excepting the tips; the feet, which are brown, have five joints each, they are terminated by two little claws and two lobes, called pulvilli; the fly is from $\frac{1}{2}$ an inch to 9 lines long, and expands from 1 inch to 13 lines.

This is a fly which is seen from June to the end of October hovering over wild and garden flowers in fine weather, and resting in cloudy days on trunks of trees and paling, with their wings closed and lying upon their backs. Some idea may be formed of the numbers of the larvæ, and the consequent benefit derived from their operations, when we state that on the 30th July, 1818, which was a very hot day, these flies were in such swarms that they quite covered the fishermen's boats at sea off Broadstairs, and they were equally abundant at Ramsgate and the Nore. When thus congregated, insects fly in one direction, not even avoiding objects that lie in their course; and in the above instance, it appears, that they were bound to the hop-gardens in Kent, where the crops often fail through the effects of the Aphides, as we have already observed. The maggots of this species are green, and I found them in July of the following year in some abundance on the sea-cabbages, *Brassica oleracea*, which grow under the cliffs near Dover. Many of them had been stung by a little parasitic fly called *Microgaster Lineola*,* the maggots of which came out of the *Scæva* larvæ, and formed little elliptical silken cocoons almost white.

20. *S. Ribesii*, *Linn.* is a similar fly in form, but smaller; the head is yellowish, the nose horny and shining; eyes coppery; horns rust-colour, black above; trunk bottle-green, scutel yellow; body black, with a large yellow or orange spot on each side of the base, then follow two broad and two narrow bands; the legs are bright ochraceous, the base of the thighs fuscous; wings the same as in *S. Pyrastri*; length $5\frac{1}{2}$ lines, expanse 11 lines.

This fly is abundant everywhere in England in the summer, especially in July: it is equally common in Scotland and Ireland, where I have taken many specimens.

21. *S. balteata*, *Linn.* is more slender in its form; the head and thorax are brassy-green, the latter with two greyish lines down the back; the face is ochraceous and hoary; horns bright rust-colour, black above; eyes as usual; scutel ochraceous, more or less brassy at the base; body elliptical, shining black, with two bright ochraceous spots on each side of the base, and uniting outside: there are also six bands of the same colour, the first and third being narrow; wings as usual; legs and under-side of body entirely ochraceous; length $4\frac{1}{2}$ lines, 10 in expanse.

During July, August, and September these flies are abundant

* Curtis's Guide Gen. 554, 1, and Brit. Ent. fol. and pl. 321.

in every garden, field, and hedge, and I have bred them even in October. The maggots are yellowish-white, with broken scarlet lines down the back, and black spots and marks between them, which are caused by the food in the intestines shining through; the head is furnished beneath with two minute hooks or teeth, and there is a tubercle at the rump composed of two lobes, with which the animal adheres to any object; and there are minute bristles on the sides. Out of one of the pupæ came three or four little parasitic maggots, which lived through the winter; and the first week of April they produced some small flies, very similar to No. 8, which I take to be the *Ceraphron Syrphii* of Bouché,* who bred them likewise from the pupæ of *S. Ribesii*. One of the Ichneumonidæ, called by Gravenhorst *Bassus albosignatus*,† also lays its eggs in the larvæ of *S. balteata*.

22. *S. scripta*, Linn. is much smaller than the foregoing insects, and the males have a much narrower body: the face is yellow; the horns orange; thorax dull green, the sides and scutel yellow; body long and narrow in the males, with two bright ochraceous spots towards the base, two bands of the same colour farther down; the penultimate segment has a V-shaped ochraceous mark on the centre, with a dot on each side, and the apex is also ochraceous, with a few black dots; the legs are entirely ochraceous; length $4\frac{3}{4}$ lines, expanse 7 lines.

This and many allied species are abundant everywhere, especially in meadows and ditches, from Midsummer to October. I may mention also that the Baron De Geir‡ describes and figures a blood-red *Acarus* or mite which seizes the Aphides by the back, belly, or neck, as a ferret would a rat, and sucks out all the juices; and I find that earwigs assist in diminishing the plant-lice, by feeding upon them in the curled leaves, where those troublesome insects shelter themselves after their nocturnal excursions.

Severe frosts are exceedingly beneficial in the destruction of noxious insects, and although the Aphides can resist cold to a considerable amount, having survived the weather when the thermometer was as low as 29° Fahr., not only are immense quantities destroyed by intense cold, but a check is given in another way to their increase, for in mild winters little doubt can be entertained that they not only survive, but are actually propagating; and Mr. W. Curtis very sensibly remarks, that as their enemies, on the contrary, exist, but do not multiply, during such periods, the Aphides get the start of them, and thus obtain an

* Bouché's *Naturg. der Insecten*, p. 175, pl. 7. fig. 33 and 36 to 39 and fig. 41.

† Curtis's *Guide Gen.* 520, 20.

‡ *Mémoires*, v. 7, p. 122, pl. 7, fig. 13, 14.

ascendancy, which once acquired is not easily overcome.* I have been surprised to see how slightly Aphides are affected by wet; and I find that the same careful observer of nature tried a few experiments to ascertain how far they could resist the action of water. Mr. W. Curtis first immersed some Aphides attached to a willow-twigg in water for sixteen hours, which did not appear to incommode them in the least, for on being taken out and placed in the sun, they increased and multiplied shortly afterwards; but when they were brushed off, they could not so long sustain the effect of water. He afterwards immersed two other sorts of Aphides, which at the expiration of twelve hours were all dead: this difference of power in the vital principle is very remarkable, and not easily explained. Their capability of resisting some gases or effluvia is likewise very astonishing: for instance, I took some Aphides from the Southernwood, both winged and apterous, and corked them up in a quill containing a piece of camphor, which produced an atmosphere that killed most insects in an hour, but the Aphides were walking about unaffected, after being confined there twenty-four hours!

DROSOPHILA† and *PHYTOMYZA*.‡—*Turnip-leaf Miners.*

Turnip-leaves are often more or less covered with whitish blisters, which are caused by the maggots of two different kinds of flies, both of which belong to the ORDER DIPTERA and the FAMILY MUSCIDÆ: it does not appear that they do much mischief to the crops, but it may be questionable whether the maggots do not occasionally generate disease in cattle feeding upon the turnip-tops, when their numbers are in excess. The first species, which is called *Drosophila*, belongs to a group, the larvæ of some living in vinegar and acid beer, many breeding in *Boleti*; and others, like the one before us, live upon the parenchyma or pulp of the leaves of various plants: some of the flies are frequently found in cellars, and are also seen running over the windows in our houses.

It is not a little singular that, as far as my observations go, the maggots of the turnip *Drosophila* form their dwellings so carefully under the upper cuticle of the leaves that not a trace of them can be seen on the under-side, whilst the habits of the larvæ of the *Phytomyza* are just the reverse: the economy of the former I will now investigate. On the 22nd of last July I saw many leaves of some English turnips disfigured by large pale blisters on various parts of the upper side (fig. 26): upon examination I

* Trans. Linn. Soc. v. 6, p. 84.

† Curt. Brit. Ent. fol. and pl. 473, Guide Gen. 1334.

‡ Curt. Brit. Ent. fol. and fol. 393, Guide Gen. 1348.

found that many of them were empty, but in two or three I detected maggots by holding the leaf up to the light (fig. 27); they were of a pale green colour, the mouth being armed with two little horny-hooks; one changed to a pupa (fig. 28) inside of the blister the same day, and another I found dead shortly after at the bottom of the tin-box in which they were placed, and in a day or two I saw another pale greenish maggot in a box with a blistered leaf, which soon buried itself under the cuticle, and changed to a pupa of a chestnut colour, with two divaricating horns on the head (fig. 29), and on the 4th of August I bred from it a fly (fig. 30), which agrees pretty well with Fallen's description of

23. *Drosophila flava*: it is ochraceous, sparingly covered with black bristles, the face is silky white, eyes black, and the lobes at the apex of the abdomen are black; the seta or bristle of the horns is likewise black and only feathered above, and there is a slate-coloured spot on the crown where the three little eyes are placed: down the centre of the thorax is a light rusty line, with the indication of one on each side; the legs are very pale ochreous; the wings are yellowish but iridescent, and the nervures are pale-brown: length 1 line, expanse $2\frac{3}{4}$.

In October numbers of the leaves amongst the Swedish turnips likewise exhibited pale patches, which were almost white, or the colour of parchment above, but, as usual, no indications of their being infested were visible beneath. In these blisters I found sometimes as many as three maggots, which I presume were the offspring of a second brood: they shortly became brown pupæ at the bottom of the box, from which I am induced to infer that they often come out of the blisters when arrived at maturity, and enter the earth to undergo their transformation to the chrysalis state. From some of the earlier pupæ I obtained two little parasitic hymenopterous flies: one appears to be the *Ceraphron niger** of my cabinet; and the other is, I believe, *Miscogaster viridis* of Walker.†

The other fly called *PHYTOMYZA*, is bred from the *under-sides* of the turnip-leaves, where the maggots form long irregular galleries (fig. 31) inside of the lower cuticle, and these miners are not visible on the upper-side of the leaf. One of the maggots changed the third week in July to a dark-brown pupa (fig. 32) beneath the epidermis, and it was furnished with two small horns at one end: on the 28th a fly came forth, which was the

24. *Phytomyza nigricornis* of *Macquart* (fig. 33): it was slate-black; the head and thorax were sprinkled with a few black bristles; the horns are brown, with a naked bristle; the head is pale ochraceous, excepting a spot on the crown; the tips of the

* Curt. Guide Genus 581 b, 41.

† *Ibid.* Gen. 638, 17.

thighs and the poisers are yellowish-white; the wings are pale slate-colour, with two strong and two faint nervures: length 1 line, expanse $2\frac{1}{2}$.

CEROSTOMA XYLOSTELLA.—*The Turnip Diamond-back Moth.**

We now arrive at the history of a small moth, which is very abundant in turnip-fields, and, according to one of my correspondents, occasionally does considerable mischief. The caterpillar (fig. 34) is spindle-shaped, of a delicate green, sometimes inclining to yellow, with a grey head; it has six pectoral, eight abdominal, and two anal feet, all of which are green. On the continent it lives principally upon the upright honeysuckle, *Lonicera xylosteum*, and attacks a great number of culinary plants, but seems to prefer the cabbage and the turnip. Godart says that it lives in a slight web generally attached to the under surface of the leaves, and when it is about to become a chrysalis, it spins within the web a cocoon like network, in which it changes to a yellow testaceous pupa (fig. 35): the moth comes forth in about eighteen days: Linnæus gave it the name of *Tinea xylostella*, from its feeding upon a honeysuckle which bears that name. It still belongs to the FAMILY TINEIDÆ, but by modern naturalists it has been separated from that immense group of LEPIDOPTERA, and is now described by Latreille and others as

25. *Cerostoma xylostella*. When at rest the wings are closed and deflexed, and the horns are projected forward in a straight line (fig. 36). It is more or less brown, the slender horns are white, a tuft of scales on the crown of the head and the disc of the thorax are whitish-ochre: the superior wings, which are long and narrow, have three or four pale spots upon the anterior margin towards the apex, and all along the inner margin is an indented white or ochraceous stripe, which forms when the wings are closed two or three diamonds upon the back; the fringe is purplish, variegated with black scales; the inferior wings, which are lance-shaped, are of an ash-colour, with a very long fringe; the body is slender and of the same colour, the apex ochraceous: length $2\frac{1}{2}$ lines, expanse 7 lines: fig. 37 magnified.

This species, says M. Duponchel,† is spread over all Europe, and has two generations in a year; the one appears in June and the other at the end of summer. In this country there seems to be a succession of broods from midsummer until the approach of winter, for I have taken specimens in the gardens near London in the end of June, at Dover in July, Scotland in August, and frequently amongst turnips in September and October in Suffolk

* Curtis's Brit. Ent. fol. and pl. 420; Guide Gen. 1031, 4.

† Godart's Lepidoptères de France, v. 8, p. 214.

and Essex. Monsieur Desjardins says* that it exists also in the Mauritius, where it makes very great ravages in the kitchen-gardens; but whether it is indigenous to that island, or has been transported from Europe with the cabbage-plants that the people cultivate there, is unknown. I have little doubt that this was the caterpillar which Mr. Dalgavings of Forfarshire mentioned as having seriously injured his crop of turnips in 1826. I am, however, particularly desirous of calling the attention of agriculturists to this enemy of the turnip-crop in consequence of having received the following communication from Mr. J. Weaver, who lives in the neighbourhood of Petersfield, Hants:—"The little moth which I have sent is one from a host of small green caterpillars which have been exciting some surprise here this summer. About the beginning of August I was directed to a field of turnips said to be infested by the 'niggers:' they proved however to be myriads of tiny larvæ, averaging perhaps half an inch in length each, slender, and somewhat tapering at both ends, and of a green colour when full fed. They were exceedingly active, and on the slightest touch would wriggle themselves off from the leaf on which they were feeding, let themselves down by a silken thread, and remain suspended till the cause of alarm had subsided, when they would regain their former position. So incredible were their numbers, that on a single plant of moderate size, and taken at random, I counted upwards of two hundred and forty!—and before the end of the first week in August every leaf, for the space of more than an acre, was completely reduced to a parched-up skeleton: not a turnip escaped them, and by the middle of the month you might have looked in vain for the smallest vestige of a green leaf on the field of their depredations; and to this day (Oct. 29th, 1837) it is as bare as if nothing had been sown there. Similar patches from a like cause may be seen in two or three other fields in this neighbourhood, where a most excellent crop is yielded in every other part. On the 9th they began spinning their cocoons, which are of the most beautiful net-like texture, some on the dried fibres of the turnip-leaves and others upon the ground. The perfect insects emerged about the 20th; but out of seventeen cocoons five moths only hatched, while the remaining twelve produced the accompanying parasite." This was one of the *ICHNEUMONIDÆ*, and is called by Gravenhorst

26. *Campoplex paniscus*:† it is black; the antennæ are slender and shorter than the body; lower part of face silvery; mouth straw-colour; body attached by a narrow neck; the apex of the female armed with a slender shortish tripartite ovipositor, like a

* *Annales de la Soc. Ent. de France*, v. 6, p. 229.

† *Curtis's Guide Gen.*, 529, 29.

tail: wings very transparent and iridescent; the nervures and stigma yellowish brown; superior with nine cells and a minute areolet; thighs bright rust colour; shanks paler, hinder often whitish, with the apex and a ring near the base pitchy; feet brown at the apex, hinder fuscous, excepting the base, which is white: length $2\frac{1}{2}$ lines, ovipositor 1 line, expanse from $4\frac{1}{2}$ to 5 lines.

This insect is abundant in July and August upon almost every umbelliferous plant, in fields and hedges, feeding in the flowers and searching for caterpillars for the purpose of depositing eggs in them.

PLUSIA GAMMA.—*The Y-moth*.*

Although I am not aware of any instance being recorded where serious mischief has been occasioned by the caterpillars of the Y-moth in this country, it has caused such ravages abroad that it is well deserving of our attention, especially when we consider the multitudes of this species of moth that often appear in our fields and gardens.

The eggs laid by the female Y-moth are very beautiful, resembling an *echinus* in shape as well as in their curiously sculptured surface (fig. 38 magnified): they are generally attached to the under-side of a leaf in considerable clusters,† and I believe that the young caterpillars are very unlike the full-fed ones: after changing their skins several times they become of a green colour, and are covered with very short hairs; the head is greenish brown; there are six white or bluish lines down the back, and a yellow streak along each side; the spiracles or breathing pores are black; they have six pectoral or horny feet, only four abdominal, and two anal, which are all green and fleshy (fig. 39): these larvæ which form an imperfect loop, in walking I have frequently found feeding upon turnip-leaves, but they will live upon a variety of vegetables, upon stinging and dead nettles, and even on grasses, if pressed by hunger. When they have arrived at their full growth they spin a woolly white cocoon, either between the folds of a leaf or against the stalk of a plant, within which they change to a pitch-coloured chrysalis (fig. 40), distinguished by a considerable protuberance at the base of the abdomen, owing to the long proboscis being bent back at that point. The beautiful moth produced from these chrysalides belongs to the ORDER LEPIDOPTERA, of the FAMILY NOCTUIDÆ, and is now characterised as the

27. *Plusia* (*Noctua*) *gamma*, *Linn.*: the tongue is very long and spiral; the horns are like fine bristles; the head and thorax

* Curt. Brit. Ent. fol. and pl. 731.

† Sepp represents them laid singly.

are of a purplish brown, the latter is crested; the wings when at rest are closed and a little deflexed; the superior are somewhat lance-shaped, shining like satin, of a dull blossom colour with a slight coppery tinge, and beautifully variegated with brown and grey, and at the centre is a pale golden letter like the Greek γ ; the body and inferior wings are smoky; the former has a few tufts of scales on the back near the base, and the latter are often of a whitish blossom-colour across the centre, leaving a broad brown margin; the fringe is whitish, with a line of blackish spots: it is $\frac{3}{4}$ of an inch long and more than $1\frac{1}{2}$ inch in expanse.

From the green colour of the caterpillars they are difficult to detect: yet they must be very abundant, from the immense quantities of the moths we see flying about fields, hedges, heaths, and gardens, from the early spring until the end of autumn, but they are most abundant in July and October. It has been remarked in France that rainy seasons seem to be more favourable to their increase than dry years; and in October, 1816, they rose in swarms in the northern departments, as persons walked over the fields.* In 1735 the caterpillars did incredible mischief to the market-gardens around Paris, eating up the peas and beans, so that only the stalks and fragments of the leaves were left, and refusing nothing but the lentils: their ravages extended to Tours, and in Auvergne and Burgundy they destroyed the crops of hemp; and not only did the gardens suffer, but whole fields of culinary plants were consumed, and so great were their numbers that at any one time several scores and more could be seen in the highways going from one field to another in search of food,† where they would not refuse either clover or grasses, but they did not touch either wheat, rye, or barley, although later in the season they attacked the oats.

These extraordinary swarms of insects, and their irregular returns, may be sometimes owing to the mildness of the foregoing winter: in the instance just related, there had been no severe frosts either in the winter or spring, so that the previous autumnal broods of caterpillars lived through the cold season, and it necessarily followed that an immense number of the moths were produced, and the spring and summer which succeeded proving favourable to their increase, they became more abundant than they had ever been known before. It is only surprising that such events do not oftener occur, when we consider the rapidity with which insects increase. Let us, for instance, suppose that no accident interfered with the progress of the different broods of this moth, of which there are two every year: it is believed that one female moth

* Godart's *Lepidop. de France*, v. 7, part 2. p. 43.

† Reaumur, *Hist. des Ins.* v. 2, p. 326.

will lay about 400 eggs, which would be transformed in a few weeks to 400 moths: if we allow half of these to be females, they would lay at the same rate 80,000 eggs, which would in the following autumn (admitting that the first was a vernal moth) become perfect insects, whose eggs, taking again half of them as females, would amount to the prodigious number of 16,000,000, which would hatch the following spring, and be ready to devastate the spot on which they were bred: there must be, consequently, innumerable agents in operation to stop their increase, although I do not happen to have met with the species of ichneumons, &c. which are destined to preserve our green crops from being annihilated by the caterpillars of the Y-moth.

Plusia gamma is a widely-dispersed insect, being found all over Europe, and it is said to extend even to the frontiers of China and Siberia: it likewise inhabits North America. Unlike most other species of Noctuidæ, this moth flies about by day, not only in the sunshine, but regardless of the weather, it will be seen on dull and even damp days hovering over flowers, and, like a sphinx-moth, thrusting in its long spiral proboscis or tongue to extract honey from the nectaries; at other times, fluttering and running over the flowers, or resting upon them with its wings closed. There is no moth more shy and difficult to catch by day, for it will seldom allow any one to come near it, but whether it detects the approach of man by its eyes, which sparkle like living rubies, or by its hearing, is not known: it darts off, however, in an instant when disturbed, and stops again a few yards off, or entirely vanishes.

Should the Y-moth caterpillars ever become fearfully abundant in our turnip-fields, it is not improbable that ducks, poultry, and sheep might be very serviceable in diminishing their numbers, if employed as recommended in the last report upon the black caterpillar.

Having now given an account of several kinds of insects connected with the turnip crops, I must leave for a future opportunity some others which are equally interesting, and not less destructive. The following summary will be useful, by placing before the reader in a concise form the results of my investigations:—

History of the APHIDES, *or* PLANT-LICE.

Every crop, both in the fields and gardens, is subject to the attacks of various species.

Two different sorts infest the *leaves* of the English turnips, one haunts the leaves of the swedes, and another the *flower-stalks*.

The *green tops* are rendered less fit for cattle when infested

with aphides, and the growth of the *plants* and the *roots* is retarded.

168 aphides were seen upon one small turnip-leaf in July.

It is by thrusting their *beaks*, called the rostrum, into the plants, and imbibing the sap, that they injure our crops.

The females are both *oviparous* and *viviparous*: they are *winged* and *apterous*.

In autumn they lay *eggs*, which hatch the following spring.

The *eggs* are laid upon the leaves, under the buds, and other secure places.

The females *bring forth* young, without sexual intercourse, for many generations.

Their *increase* is prodigious: it is calculated that one female might be the progenitor of upwards of 5900 millions of descendants in one year.

The *eggs* hatch about the period of north and north-east winds, in March and April.

Their increase is accelerated by *damp sultry* weather as the season advances.

Electricity probably often causes their simultaneous appearance.

The *aphides* can *walk* about as soon as they are born, and are able to do so until their lives are terminated.

Abundant in August, September, and October, and even at the end of November, secreted beneath the diseased leaves.

It is doubtful if these species deposit the saccharine matter called *honey-dew*.

Cutting off the *infested leaves* and destroying them on the spot, or carrying them away in sacks to be burnt, is the best remedy.

Tobacco and *lime water* will kill the *aphides*. Lime-dust, if strewn in dry weather, is an effective cure.

They often do not suffer from *heavy rains*.

Insectivorous birds, and various *insects*, our best friends in checking their increase.

The *lady-birds* and their *larvæ* are particularly useful in destroying the aphides.

Immense *swarms* of the *lady-birds* sometimes appear on our shores.

A little fly called *Aphidius* lays its *eggs* in the *aphides*, and when they hatch the maggot destroys the aphid.

These again become the *victims* of other small flies, called *Ceraphron Carpenteri*, *Cyrtogaster vulgaris*, and *Colax aphidii*.

Some of the *Cynipsidæ*, or *gall-flies*, are also parasites, which live in the aphides as maggots.

Four other *wasp-like flies* collect the aphides as food for their young.

The *Aphis-lion*, or larva of the *Golden-eye fly*, destroys the aphides; and the *maggots* of some two-winged flies called *Syrphi* are still more serviceable in their destruction.

These are, however, in their turn infested with a *parasite* called *Ceraphron syrphi*.

Severe frosts destroy the aphides, but they are able to propagate in mild winters.

When immersed in water for sixteen hours, it has not killed them.

An atmosphere strongly impregnated with *camphor* did not affect them in twenty-four hours.

The TURNIP-LEAF MINERS may generate diseases in cattle, when they greatly abound.

One called *Drosophila flava* causes large blisters on the upper sides of the leaves, which contain the maggots.

The other, named *Phytomyza nigricornis*, is the parent of a maggot which eats galleries in the under-sides of the leaves.

The TURNIP DIAMOND-BACK MOTH: the larvæ feed upon the turnip-leaves, and sometimes nothing but the fibres are left.

The *chrysalis* is inclosed in a net-work cocoon, attached to the dried fibres, or formed upon the ground.

It is found all over *Europe* from Midsummer to November, and does great mischief in the kitchen-gardens in the Mauritius.

Upwards of 240 of the caterpillars have been found upon one plant.

A *parasitic Ichneumon* lays its eggs in the caterpillars.

The Y-MOTH lays its eggs on the under-side of turnip-leaves and other plants.

The green caterpillar feeds upon the turnip-leaves and a variety of plants.

The *chrysalis* is inclosed in a white web, often spun in the folds of the leaves.

The moths are abundant from April till October, especially in the latter month and in July.

Rainy seasons seem to be congenial to their increase.

In October, 1816, the moths swarmed in the north of France.

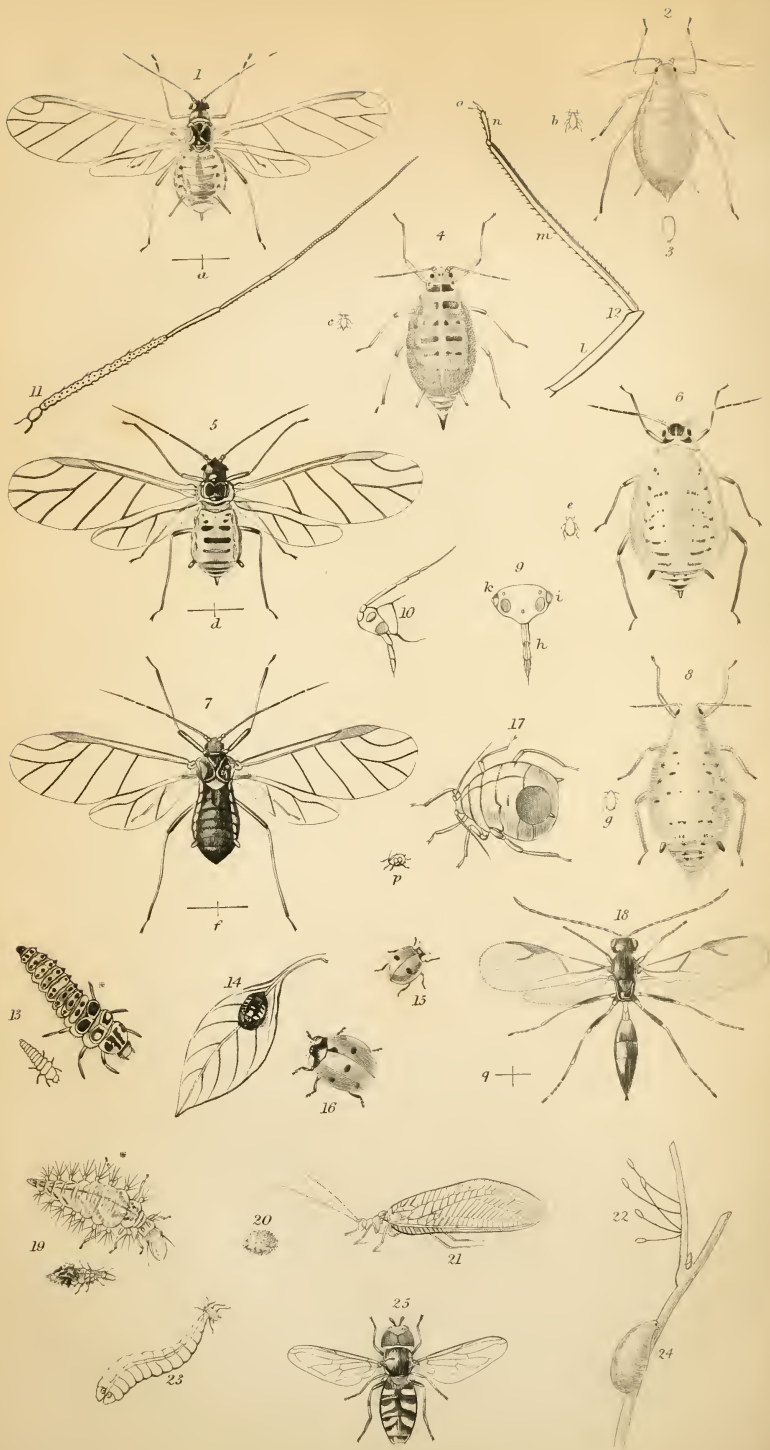
In 1735, the caterpillars ate up all the vegetables around *Paris*, excepting lentils.

Their ravages extended to the centre and south of France, where they consumed the *hemp-crops*, and did not refuse *grasses* and *clover*.

They spared the *corn-crops*, but attacked the *oats* later in the season.

The previous winter and spring had been very mild.

One female Y-moth in the spring might become the progenitor



of 16,000,000 of caterpillars, in the space of twelve months, viz. from the spring of one year to the following spring.

It is dispersed over all *Europe*, to the confines of *Siberia* and *China*, and is also an inhabitant of *North America*.

It *flies* by day as well as at night.

Ducks, poultry, and sheep recommended to destroy the caterpillars.

EXPLANATION OF THE PLATES.

- Fig. 1*. *Aphis Rapæ*, male. *a* The natural dimensions.
 Fig. 2*. —————, female. *b* The natural size.
 Fig. 3*. —————, a young one just excluded.
 Fig. 4*. *Aphis dubia*. *c* The natural size.
 Fig. 5*. *Aphis Brassicæ*, male. *d* The natural dimensions.
 Fig. 6*. —————, female. *e* The natural size.
 Fig. 7*. *Aphis Floris-Rapæ*, male. *f* The natural dimensions.
 Fig. 8*. —————, female. *g* The natural size.
 Fig. 9*. Front view of head of an *Aphis* magnified.
 h The rostrum or beak.
 i The compound eyes.
 k The three ocelli or simple eyes.
 Fig. 10*. The head in profile of an *Aphis* magnified, showing the rostrum and antennæ.
 Fig. 11*. One of the antennæ or horns greatly magnified.
 Fig. 12*. One of the six legs magnified.
 l The thigh or femur.
 m The shank or tibia.
 n The foot or tarsus.
 o The claws and pulvilli or suckers.
 Fig. 13. The larva of a *Coccinella* or lady-bird.
 * The same magnified.
 Fig. 14. The pupa or chrysalis of ditto.
 Fig. 15. The twin-spotted lady-bird.
 Fig. 16. The seven-spotted ditto.
 Fig. 17*. The indurated skin of a female *Aphis*, from which a parasitic fly has been hatched.
 p The natural size.
 Fig. 18*. *Aphidius Rapæ*, the parasitic fly alluded to.
 q The natural size.
 Fig. 19. The larva of the golden-eye, called the *Aphis-lion*.
 * The same magnified, with the lichen removed.
 Fig. 20. The cocoon formed by the larva.
 Fig. 21. The golden-eye, *Chrysopa perla*, a female, at rest.
 Fig. 22. The eggs of ditto, copied from Reaumur.
 Fig. 23. The maggot or larva of *Syrphus pyrastris*, sucking an *Aphis*.
 Fig. 24. The pupa of ditto.
 Fig. 25. *Syrphus pyrastris*, male.

Fig. 26. A turnip-leaf, upper-side.

Fig. 27. The maggot of *Drosophila flava*, feeding under the cuticle.

Fig. 28. The pupa of ditto.

Fig. 29*. The same greatly magnified.

Fig. 30*. *Drosophila flava* represented flying.

r The natural dimensions.

Fig. 31. The gallery formed on the under-side of a turnip-leaf by the maggot of *Phytomyza nigricornis*.

Fig. 32. The pupa of ditto secured under the cuticle.

Fig. 33*. *Phytomyza nigricornis* represented flying.

s The natural dimensions.

Fig. 34. The caterpillar of the Turnip diamond-back moth.

Fig. 35. The pupa of the same inclosed in the cocoon.

Fig. 36. The moth from the same represented at rest.

Fig. 37*. The same flying and magnified.

Fig. 38*. The egg of the Y-moth.

t The natural size.

Fig. 39. The full-grown caterpillar walking.

Fig. 40. The chrysalis in its web.

Fig. 41. The Y-moth flying.

Obs. All the figures are drawn from nature, excepting 22, 23, and 34, and the numbers with a * attached indicate that the objects referred to are represented much larger than life.

London, February, 1842.

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VIII.—*On the Comparative Value of different Kinds of Fodder.* By the Rev. W. RHAM.

As the following table of the comparative value of different kinds of fodder in feeding cattle may not be generally known, I have translated it from the French. It has been published by M. Antoine, at Nancy, and is the result of experiments made by the principal agriculturists of the Continent, Thaer, Gemerhausen, Petró, Rieder, Weber, Krantz, André, Block, De Dombasle, Boussingault, Meyer, Plotow, Pohl, Smée, Crud, Schwertz, Pabst. It is unnecessary to give the figures which each of these experimentalists have set down, but the mean of their experiments being taken, there is more chance of the result being near the truth. Allowance must be made for the different qualities of the same food on different soils and different seasons. In very dry summers the same weight of any green food will be much more nourishing than in a dripping season. So likewise any fodder

raised on a rich dry soil will be more nourishing than on a poor wet one. The standard of comparison is the best upland meadow-hay, cut as the flower expands, and properly made and stacked, without much heating; in short, hay of the best quality. With respect to hay, such is the difference in value, that if 100 lbs. of the best is used, it will require 120 lbs. of a second quality to keep the same stock as well, 140 lbs. of the third, and so on, till very coarse and hard hay, not well made, will only be of half the value, and not so fit for cows or store cattle, even when given in double the quantity. While good hay alone will fatten cattle, inferior hay will not do so without other food.

I shall give the table as it stands, and add the notes which accompany it:—

	lbs.	
Good hay	100	is equal in nourishment to
Lattermath hay	102	
Clover, hay-made	90	when the blossom is com- pletely developed.
Ditto	88	before the blossom expands.
Clover, second crop	98	
Lucerne hay	98	
Sainfoin hay	89	
Tare hay	91	
Spargula arvensis, dried	90	
Clover hay, after the seed	146	
Green clover	410	
Vetches or tares, green	457	
Green Indian corn	275	
Green spargula	425	
Stems and leaves of Jerusalem arti- choke	325	
Cow-cabbage leaves	541	
Beet-root leaves	600	
Potatoe halm	300	
Shelter wheat-straw	374	
Rye straw	442	
Oat straw	195	
Peas halm	153	
Vetch halm	159	
Bean halm	140	
Buckwheat straw	195	
Dried stalks of Jerusalem artichokes	170	
Dried stalks of Indian corn	400	
Millet straw	250	
Raw potatoes	201	
Boiled ditto	175	
White Silesian beet	220	
Mangold-wurzel	339	
Turnips	504	

	lbs.
Carrots	276
Cohlkalis	287
Swedish turnips	308
Ditto, with the leaves on	350
Grain—Rye	54
Wheat	45
Barley	54
Oats	59
Vetches	50
Peas	45
Beans	45
Buckwheat	64
Indian corn	57
French beans, dried	32
Chestnuts	47
Acorns	68
Horse-chestnuts	50
Sun-flower seed	62
Linseed cake	69
Wheat bran	105
Rye bran	109
Wheat, peas, and oat chaff	167
Rye and barley chaff	179
Dried lime-tree leaves	73
—— oak leaves	83
—— Canada poplar leaves	67

Observations.

Lattermath hay is good for cows, not for horses. The second cut is generally considered as inferior in nourishment to the first. New hay is not wholesome. At Paris, when a load of 1000 kilos is bargained for, the seller must deliver—if between hay-making and October 1, 1300 kilos—from October 1 to April 1, 1100 kilos—and after April, only 1000. This is fair, and allows for loss of weight in drying. In London, a load of new hay is 20 cwt.; of old hay, only 18 cwt. Spurney (*Spergula arvensis*) is excellent food for cows; but, except on poor moist sands, the crop is so light as not to pay for cultivation. It grows rapidly, and makes a good intermediate crop between barley-harvest and winter.

The dried halm of the *Trifolium incarnatum*, after the seed is ripe, is little better than straw. Clover, lucerne, and sainfoin are generally supposed to lose three-fourths of their weight in drying; but in general they lose more, especially in moist climates, where the sap is more diluted. When touched by the frost, they become very unwholesome, and should never be given to cattle except quite dry.

All beasts are fond of the green stems of the Indian corn or maize; but it has not yet been much cultivated in Britain. If sown in May, so as to be free from frost, after the seeds have been well soaked in water, the crop will come up well, and be ready to cut green in September and October, without ever producing any seed; but within the stalk will be found the embryo of the seed ear, which is extremely sweet and pleasant to the taste. It is very good boiled as greens. Green spurrey gives excellent milk and butter when the cows are fed on it. There is a variety which is much larger than the common field-spurrey, and which is worth attention.

The stems of Jerusalem artichokes when young may be good fodder, but they soon get hard and woody. The leaves of the cow-cabbage, when given quite fresh, and none of them withered or decayed, are excellent for cows, and give no taste to the butter. Straw is, on the whole, but poor food, and unless cattle have something better with it, they will not keep in any condition; when given with turnips or other roots, straw corrects their watery nature, and is very useful; cut into chaff it is very good for sheep when fed on turnips and oil-cake, and when newly thrashed is as good nearly as hay. By a judicious mixture of different kinds of food, a more economical mode of feeding may be substituted for a more expensive one, and the same result obtained. The value of straw depends much on the soil: a very clean crop will not give so nourishing straw as one containing many succulent weeds. Peas and vetch halm are superior to straw, especially when cut into chaff: it is by some thought equal to hay. The same may be said of bean halm not left too long in the field, and cut before it is completely dry. Buckwheat halm is of little value: it is thought unwholesome if given to sheep.

The dried stems of the Jerusalem artichoke must be cut into chaff, and then boiled or macerated in water, otherwise the cattle cannot chew them. The same may be said of the stems of millet, sorgho, and maize. Raw potatoes increase the milk of cows, but they must be given with caution, and only a few at first, till the stomach is accustomed to them; boiled, they fatten every kind of stock; mixed with cut chaff, they are excellent for horses: 14 lbs. of boiled potatoes will allow a diminution of 8 lbs. of hay; hence their value in this way is easily calculated. When hay is 4*l.* 4*s.* a load, it is just $\frac{1}{2}$ *d.* per lb.; the 14 lbs. of boiled potatoes are therefore worth 4*d.* And 56 lbs. being reduced by boiling to 42 lbs., the potatoes are equal in value to 2*s.* per cwt., which is 40*s.* per ton. From this must be deducted the expense of boiling; where fuel is cheap, this will be compensated by the dung, which would have been lost had the potatoes been sold. If 14 lbs. of boiled potatoes are equal to 16 lbs. raw, raw potatoes

are one-half the value of hay; and if hay is $\frac{1}{2}d.$ per lb., raw potatoes are worth $\frac{1}{4}d.$ per lb., 1s. 2d. the half cwt., and consequently more than when boiled.

Every kind of cattle eat turnips except horses. Turnips will feed store pigs, but they will not fatten on them. Carrots and parsneps are excellent for horses, and, when boiled, will fatten hogs. Ruta-baga is liked by horses: it makes their coats fine, but must not be given in too great quantity, or it will gripe them.

In France, the flour of buckwheat, seasoned with salt and mixed with water, is used to fatten oxen, sheep, and swine.

Hogs fattened with chestnuts have fine-flavoured flesh.

If the horse-chestnuts are boiled, the bitter part is boiled out, and cattle will eat them readily: mixed with other food, they soon become accustomed to them.

Oil-cake varies in nutriment, as in price: if linseed-cake is 17·50, rape-cake will be 16·60, cameline and hemp-seed cake 9, poppy-cake 8.

Bran is good for horses mixed with oats, and for milch cows excellent. If it can be had good at $\frac{1}{2}d.$ per lb., it is worth as much as the best hay.

The value of dried leaves is taken chiefly from their analysis by Sprengel; but they must be gathered when green, and dried like hay.

On the Feeding of Animals.

A certain quantity of food is required to keep an animal alive and in health: this is called his necessary ration of food: if he has more, he will gain flesh, or give milk or wool.

An ox requires 2 per cent. of his live weight in hay per day; if he works, he requires $2\frac{1}{2}$ per cent.: a milch cow, 3 per cent.: a fatting ox, 5 per cent. at first; $4\frac{1}{2}$ per cent. when half fat; and only 4 per cent. when fat; or $4\frac{1}{2}$ on the average. Sheep grown up take $3\frac{1}{3}$ per cent. of their weight in hay per day, to keep in store condition.

Growing animals require more food, and should never be stinted.

Winkfield, March, 1842.

IX.—*On Cottage Economy and Cookery.* Compiled by FRENCH BURKE, Esq., from Essays submitted to the Royal English Agricultural Society.

ON directing their attention to improvement in the condition of our peasantry, it occurred to many Members of the Royal Agricultural Society of England, that few objects would tend more to add to the comforts of the labouring population than to furnish them with plain instructions for some better modes of preparing their food, without any increase of expense. To use without waste the food which Providence supplies for the wants of man is indeed of the greatest importance to those who have but little to spend; and nothing so completely disarms the stings of poverty as the means of rendering a scanty pittance capable of producing a comfortable meal. If, therefore, by teaching them a little of simple cookery, it can be occasionally so changed as to make it somewhat more savoury at the same cost, there can be little doubt that it would materially add to their comforts, and thus attach them still more to their homes. For although they consume far more animal food than the foreign peasantry of Europe, they yet do not fare so well; and that solely by their different mode of preparing their victuals.

The Society therefore offered a premium, in the course of last year, “for the best directions to enable labourers to prepare wholesome, nutritive, and palatable food, in the most economical and easy manner:” not with any intention to lessen its quantity, but to point out some simple means of rendering it occasionally more pleasant to the palate, and withal more digestible and healthful. Numerous essays were accordingly presented to the Council, and, after careful examination, that written by a female—who describes herself “as having, during a long life, passed it in a village some miles distant from London, where she has brought up a large family, with due attention to economy, and with constant opportunities of witnessing the modes of life of her poorer neighbours”—was deemed entitled to the prize. Some of the other essays, however, containing hints which were thought worthy of attention, portions of them have been made use of in the following account, with the consent of the authors. It will be gratifying to find that these and similar instructions have the effect intended; but their success must depend in a great measure on the habits of the poor themselves: contentment will give a flavour to the poorest fare, and plenty goes hand-in-hand with frugality.

It should be observed that the prices herein stated are those of the metropolis. Large deductions must, therefore, in some instances be made from them, so as to meet those current in markets

far distant from London, and in remote parts of the country; but this can occasion no real inconvenience, as every one can reduce the cost of any article to the sum usually paid for it where he resides.

There can be little doubt that bacon, household-bread, and cheese, washed down by a draught of strong beer, is a wholesome and substantial meal for a working man; and, if he can but afford it, he will seldom find a better. Fresh animal food is, however, more nutritious; as bacon, although it goes farthest in family use, and is therefore more commonly employed by the poor, yet occasions much greater perspirations after hard labour, and thus not only creates more exhaustion, but a little change, where it can be had, is both pleasant as well as wholesome. When a cottager has a garden and fattens a pig, he seldom goes to the butcher until the bacon is all consumed; but he would do better by occasionally buying a pound or two of meat to eke out the bacon until he can kill another hog.

With regard to strong beer, we are far from decrying its use in moderation; but, independently of its cost, although its excitement gives momentary strength, yet we know, from those who have tried it, that continual labour will be better performed by a man who during the day drinks only water mixed with some powdered ginger, and leaves the beer to enjoyment with his wife at night; for although the malt liquor exhilarates the spirits, and enables a man to perform more work for an hour, yet this stimulus leaves him in a more exhausted state than before he drank it. The powder is extremely cheap: it warms the stomach, and a very small quantity, which can be mixed in a moment, with a pint of water, will be found a more invigorating draught in warm weather than the same quantity of common harvest-beer.

It is a great error to suppose that butter and cheese are less expensive than meat, if it be judiciously purchased and economically prepared; but the poor are, in marketing, oftentimes more anxious to obtain a portion of the best joints than to content themselves with those of inferior price, although these generally contain as much, and sometimes more, real nourishment. The trimmings of the joints and the coarse parts, as well as the bones, when flavoured with various sorts of vegetables, and thickened with either rice, barley, or oatmeal, can be converted into several savoury dishes at a very trifling cost. Of the various kinds of meat, beef and mutton are decidedly to be preferred; and, in regard to cookery, stews of different sorts are not only the most economical, but have the advantage of procuring for the family a warm supper of some variety after the toil of the day is over. Of these, perhaps, the cheapest may be made from a *shin of beef*, which usually weighs from 16 to 20 lbs.; and, if the whole be

purchased, may commonly be got for 2s. or 2s. 6d.; or, if only a portion be taken, at $2\frac{1}{2}d.$ to 3d. the pound. The better way is, therefore, for two or three families to join; but as that can only rarely be done, then buy only so much as will serve a couple of days for a man, his wife, and two children under ten years of age (*for which number in family these instructions are intended*), and dress it as follows:—

Cut off the meat into slices, break the bone into small pieces, and put the whole into a saucepan, covered with a quart of water, until it boils. Then skim off the grease (but do not throw it away, as it will afterwards serve for frying), and add 2 quarts of water, 2 large onions, carrots, and turnips, cut into small squares, and a few grains of whole pepper, with sufficient salt for seasoning. Put the saucepan then on one side of the fire, to simmer gently until the meat is tender; which, although it will take from four to five hours, yet does not require any attendance. The half of it may be left to be warmed up the following day; and the bones should be again stewed down in a small quantity of water, to add to the soup. If this be done in that common kitchen utensil the iron digester (which no cottager should be without), a great deal of fatty substance will be extracted even from these bare bones, and made, with a little more vegetables, into tolerably good broth. The whole cost for the two days, even supposing the vegetables to be purchased, will be—

	s.	d.
Meat, say 4 lbs., at $2\frac{1}{2}d.$ per lb. . . .	0	10
Vegetables, pepper, and salt	0	4
	<hr/>	
	1	2

Indeed, if the cottager has a garden, and if the meat can be got, as frequently is the case, at a less price, these substantial meals may each be had for 3d. or 4d.; and it may be observed, that in all those large towns where there are regular butchers, the trimmings of mutton—that is to say, the small bones and pieces cut from the neck, breast, loin, and different joints—can generally be had at a very cheap rate: nor ought they to be despised, for the meat is of the best, and a stew made from such trimmings is just as good as if it were cut from the prime parts of the carcass.

A *bullock's heart* weighs from 5 to 7 lbs. The price in London is never more than 1s. 6d., and it may frequently be got for a shilling; but, say that it weighs 6 lbs., and costs 1s. 3d. The meat is very solid, and the flavour so much relished, that many persons in good circumstances prefer it to calves' heart, which is often served at gentlemen's tables. Nor does it require much knowledge of cookery in the dressing, which is done as follows:—Wash it well, and dry it thoroughly; then prepare the

seasoning, made with crumbs of bread, thyme and parsley, or any sweet herbs, and an onion chopped fine, with a little suet, and some pepper and salt—all mixed together and put into the heart; the opening of which is to be sewn up, so as to prevent the stuffing from getting out. Peel a good quantity of potatoes and onions, which place in a large deep dish, with the heart over them upon a trivet, and send it to the baker's. A bit of lard should also be sent with it, with which it should be occasionally rubbed, in order to prevent the skin from becoming too hard. Or, if you have a Dutch-oven and a good fire, it may be roasted, and the charge of baking saved. The cost will be as follows:—

	s.	d.
Heart	1	3
Herbs, suet and lard	0	3
Potatoes	0	1½
Baking	0	1½
	<hr/>	
	1	9

Which is much more than can be afforded for one day's consumption; but, as there are no bones, and the meat, as already said, is very solid, it will last full three days, or even four, if used with economy. On the first it will, of course, be eaten without bread; and on the following days a portion may be either warmed up in a saucepan with a little water and a spoonful of vinegar, or cut into slices and fried with onions.

The *midcalf* is also a solid and very nutritious part, which may be got for a mere trifle, and will last for two or three days if dressed in the following manner:—Put a layer of potatoes which have been partially boiled, at the bottom of a deep earthen jar; cut a portion into slices with a little bacon, placing them in regular order upon the potatoes, together with sliced onions and pot-herbs; then another layer of potatoes and midcalf alternately, until the whole is cut up: fill the jar (which should be very deep) with potatoes nearly to the top, and fill it quite up with water; cover it close up, and either stew it gently by the fire, or put it into the oven for some hours, until the meat is tender.

A pound of any fat meat, cut into square pieces, without bacon, and dressed in the same manner, will also make an excellent stew in much less time—say a couple of hours—and equally without attendance.

There is, however, no part of the bullock which produces more nutritive food than the head; for the one-half, or what is usually called the "*ox cheek*," will make delicious stews, with soup for at least three or four days' consumption. The price of this in the winter season is, however, generally 2s., which is a startling sum for a labourer, but in summer it can always be procured for

1s., and should be dressed thus:—Clean it well, and let it lie in water until the next morning, when it must be wiped dry, and placed over the fire in a large saucepan, only just covering it with water until it boils; then leave it to cool, and skim off the fat (keeping it for further use). When cold, fill the saucepan with water; add a couple of whole onions, with three or four good-sized carrots and turnips, cut into small pieces, and a bundle of sweet herbs tied together, seasoning it with pepper, salt, and a little vinegar. Leave it to stew, without allowing it to boil, until the liquor is reduced to one-half, and the meat becomes tender, and the soup tastes strong and palatable; a portion of which will be quite sufficient for the children, with a piece of bread, without any of the meat. The brains should, however, be taken out, and mixed up in the same manner as stuffing for the heart, and either fried separately, or made into balls and put into the stew.

The next day, as much of the head as may be wanted for the family should be sliced off and warmed up along with the remaining soup. The day following that, take off all the meat that remains, break up the bones into small pieces, and let them stew by the fireside for some hours, in three or four quarts of water; then take out the bones and put in the meat, thickening the liquor either with vegetables, as before, or with peas, rice, barley, or oatmeal. The soup will cut like jelly when cold, and improves upon being warmed up. Neither does it cost much more than the price of the head; and we know that, if that be of large size, it would in winter last nearly a week with good management. This, however, cannot be expected in warm weather, and it takes a great deal of cooking, which at that season is inconvenient. In the summer, however, when the labourer's wife is not uncommonly employed in the field, and fire cannot be kept up for cookery, it is a good plan to purchase a few pounds of the flank of beef, which can always be got for 4d. or 5d. the pound. It contains no bone; and if well salted, boiled, then pressed under weights until flat, and afterwards rolled up and tied together, it makes a good and cheap relish when cut into thin slices and eaten cold between slices of bread, in the manner of a sandwich.

A poor man can seldom afford to purchase even the coarsest joint of mutton; but, if he lives near a town, he can often get the *sheep's head and pluck* for less than 1s. 6d., indeed very frequently for a shilling, and with these his wife can make up four hot meals, in the following manner:—

The whole should be well cleaned and covered with salt and water, which should be occasionally changed until they are wanted. On the first day, take the heart, milt, and sweetbread, sliced and seasoned with pepper and salt, and make them into a pudding covered with a paste made of flour mixed with a little

finely chopped suet. It will take nearly two hours boiling; and, if the paste be thick, will not require bread. On the second, cut the liver and lights into slices, and fry them with half a pound of bacon; at the same time boiling half a stone of potatoes, and only using the one-half of the whole quantity. On the next day, dress the remainder in the same manner, only slicing the potatoes also into the pan along with an onion, and fry them with lard or dripping. On the fourth, stew the head in a couple of quarts of water; and when nearly done, add half a pound of rice with an onion and seasoning, and let it simmer gently until the rice absorbs the whole of the broth.

These substantial and truly savoury meals may be eaten with potatoes only, as bread is not necessary; and the cost of the whole will be as follows:—

	s.	d.
Head and pluck, say	1	3
$\frac{1}{2}$ lb. of bacon	0	$3\frac{1}{2}$
Suet and dripping	0	$2\frac{1}{2}$
1 lb. of flour	0	2
$\frac{1}{2}$ lb. of rice	0	$1\frac{1}{2}$
1 stone of potatoes	0	4
Spice and onions	0	$1\frac{1}{2}$
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	2	6

or $7\frac{1}{2}d.$ for each, if the potatoes be purchased by the bushel in the country. A few vegetables, such as carrots, turnips, and celery, cut small, may be previously boiled in the iron pot, and when done added to the stew.

On the subject of *stewing meat* the following hint may be advantageously adopted by many cooks who consider themselves mistresses of their art; it is this:—Take a piece of boiling beef with some fat to it, and a little seasoning; but without water, gravy, or liquid of any sort. Put it into an earthen jug closely covered, and place that within a large iron or tin pot nearly filled with cold water, then lay it so near the fire as to keep up a gentle simmer, without letting it boil. It will require several hours, according to the weight of the meat, which should be stewed until quite tender; it loses nothing, and will yield a large quantity of the richest gravy. It is decidedly the best mode of dressing that universal French dish—“*bœuf bouilli*”—and the cottager’s wife can bring it to her table in as great perfection as any cook to a nobleman: adding to it, if she pleases, some carrots and other vegetables, to form a family dish.

Of plain roasting and boiling nothing need be said, as every married woman must be supposed to understand those common modes of cookery; but there is, perhaps, no dish which in the

summer appears more frequently upon the poor man's table than *bacon and cabbage*; which, although boiled in the same pot, are put in separately. But it will be found a great improvement if, instead of that, a hole be cut in the heart of the cabbage, and a quarter or half a pound of fat bacon is thrust into it as a plug. The head of the cabbage should then be tied over, so as to confine the leaves, and the cabbage boiled in a napkin, to prevent all escape of fat, which will thus be imparted to the vegetable, and render it so much more mellow and savoury, that any housewife who tries it will never dress it in any other way. Bacon is also frequently fried with potatoes or chopped cabbage, and forms a savoury meal for the family supper; but half the quantity of bacon, if stewed for a couple of hours with different kinds of vegetables in a moderate quantity of water thickened with a handful of oatmeal, would be equally palatable, and go much farther.

In the summer also, *eggs*, being cheap, are much used by the peasantry, and almost in every instance *fried*, either alone or with bacon. An agreeable change may, however, be made by frying three or four sliced onions until they are well browned; and while the onions are frying, having your eggs broken into a basin, and beaten with a fork for a couple of minutes. Season with pepper and salt; and then pour them over the onions, taking care to have sufficient butter or dripping in the pan to prevent them from adhering to the bottom; and in this manner they will form a very good *omelet*, which will be done in the course of three or four minutes. Or, if frying be inconvenient, the Irish mode of "*battered eggs*" may be employed, by merely putting the eggs (after their being beaten up in the foregoing manner) into an earthen pipkin, greased inside, and stirring them together for about the same time.

That very nice dish known as "*toad-in-a-hole*," although somewhat expensive, yet serves well for a Sunday's dinner; as, being sent to the baker, it will not prevent the wife from going to church. It is made as follows:—Make a batter with a pound of flour, a couple of eggs, and a pint of skim-milk, and put into the centre of it a pound or a pound and a half of any kind of meat. If fat, the batter may be made without milk, and even without an egg, though it will be better if those ingredients be added. The costs of the best mode will be—

		s.	d.
1 lb. of flour	.	0	2
1 pint of milk	.	0	0½
2 eggs	.	0	1
Meat, say	.	0	7
Baking	.	0	1½
		<hr/>	
		1	2

Fresh fish, except upon our coasts, or when a glut of *mackerel*, *pilchards*, or *herrings* is brought to market, is out of the reach of the poor; but the latter, when salted, make a good relish to potatoes either fried or boiled. When fresh, they may, however, be kept sweet for a long time by cutting off the head, fins, and tail, and laying them in the bottom of a jar, sprinkled with pepper and salt, with alternate layers of sliced onions, until the jar is full: then pour in vinegar and send it to be baked; or they may be eaten cold, as a relish, with potatoes.

The despised little *sprat* is seldom salted; but if eaten fresh it is very nutritious, and so cheap that on our coasts it is sold to the farmers for manure at the rate of 6*d.* to 7*d.* the bushel. Now if a quantity of these are deprived merely of their heads and tails, without being gutted, then fried with cold sliced potatoes, they make a capital dish; or, when browned, if the contents of the pan be mixed, quite hot, with a quantity of boiled rice, it will be found to form a more savoury and substantial meal than when eaten with bread.

Fish, however, although yielding a very comfortable abundance to a great mass of the labouring population, yet is not nearly so nutritious as meat. It should not, therefore, be the constant diet of a working man; and when he can change it, during a couple of days in the week, for beef or bacon, he should always do so.

Cheap soups add greatly to the comfort of a family; and it would be well if the housewife would pay attention to the few simple and economical modes of preparing them and vegetables, as stated here and in other tracts on the same subject: to which may be added this observation; that, in whatever way they are made, the flavour will always be greatly improved if the onions (which should always form a portion of the contents) are sliced and fried in a little fat of any kind before being put into the soup. A common mistake in making soup, as well as in boiling meat, is to boil it much too fast, and for too short a time. The pot, in fact (and an earthen pot is both the cleanest and the best) ought to be almost always kept merely simmering by the fire; and the smallest fire is large enough, if the soup be allowed to remain near it long enough.

The liquor in which any meat is boiled should always be saved for the making of soup, and the bones even of fish should also be preserved; for, although quite bare of meat, yet if stewed down for several hours, they will yield a species of broth, which along with peas or oatmeal will make good soup. A lot of bones may always be got from the butcher for 2*d.*, and they are never scraped so clean as not to have some scraps of meat adhering to them. Put them into an iron pot—a digester, if you have one—large enough to hold a gallon; and in winter, when the cottage is

never without a fire, fill the pot with water, letting it boil for three or four hours, until it tastes something like strong broth, and is reduced to less than a couple of quarts; then, having taken out the bones, put into the liquor a quantity of any vegetables you may have at hand—cut small, and not forgetting the fried onion—and let them stew until they are tender; when nearly done, throw in a few crusts of bread, and it will be found a capital dish of soup. This done, the bones are to be again boiled in the same manner, but for a longer time, and the broth may be made the next day into a stew with rice. Nor is this all, for the bones, if again boiled for a still longer time, will once more yield a nourishing broth, which may be made into pea-soup; and when thus done with, may either be sold to the crushers, or pounded by yourself and used as manure for your garden.

It is not, however, always that broth can be had; but, even in that case, it must not be supposed that the soup cannot be made without either broth or meat; for it has been tried according to the following receipt for *pea-soup*, both by the lady who sent it to the Society, as well as by the compiler of these essays, and has, in both instances, been found excellent:—To three quarts of boiling water add a pint of peas, and let them boil till tender, then mash them together so as to form a paste, and put them back into the water along with a quantity of carrots, turnips, celery if you have any, all cut into dice, with some sliced onions, and fry the whole in the dripping-pan, keeping them well floured while frying, to prevent their burning. After this, let the soup simmer gently for a couple of hours; and if too thin, thicken it with a handful of oatmeal; season it with pepper and salt and a little dried mint, and it will serve for a family of four during two days. Split-peas are commonly used, yet whole-peas are not only quite as good, but cheaper. The cost will be at the most 3*d.*; or, if oatmeal be used, a pint will be sufficient, the usual price being only 2*d.*; but pea-soup is the preferable of the two. The peas should, however, be always left to soak during the night, and the next day made into soup with soft water; for if hard water be used, the peas will not become tender or mix into that smooth consistence which is necessary to make it good. If soft water cannot be had, a small piece of soda put into the water will, however, have the effect.

Vegetable soup may also be made thus:—Take the heart of a cabbage, or some cabbage-sprouts, or spinach, two or three turnips and carrots cut small, and a little bruised celery-seed, if you cannot get it in the root, and boil them in about three pints or two quarts of water for an hour. When done enough, slice three good-sized onions and fry them till well browned; put them

into the soup with some crusts of bread, and let the whole boil together for a quarter of an hour.

It will thus be seen that these soups can be made for very little money, if the labourer has a garden; and, indeed, the late Dr. Kitchener has published a receipt for making a gallon of *barley-broth* for a groat. Having tried it, we here give a copy of it; but we should say, that half the quantity of water is quite sufficient for the materials, and that it requires four or five hours to make it well:—"Put 4 ounces of Scotch barley (previously washed in cold water) and 4 ounces of sliced onions into 5 quarts of water; gently boil for an hour, and pour it into a pan; then put into the saucepan 1 or 2 ounces of clean beef or mutton suet, or 2 or 3 ounces of fat bacon minced. When melted, stir into it 4 ounces of oatmeal; rub these together till you make a paste, and, if this be properly managed, the whole of the fat will combine with the barley-broth, to which it must be then added by degrees, about a spoonful at a time, stirring it well together till it boils. Season it at pleasure, and let it simmer for a quarter of an hour. The flavour may be varied by doubling the quantity of onions and frying them, or by using a clove of garlick or an eschalot; and it may be thickened with ground rice or peas, instead of oatmeal."

Rice is very little used by the poor of this country, or even by the middle classes of society, and it is inconceivable how much they would gain in comfort by its more general employment, for it contains a great deal of nourishment, and is perhaps the cheapest food that can be put upon the table. It forms the only subsistence of millions of our fellow-creatures in the Indies, who never taste anything more substantial, and yet live long and healthfully, and we cannot too strongly recommend it to the cottager. There is, however, a very foolish and unfounded prejudice entertained against it by the lower classes, among whom it is very generally thought to be "bad for the eyes," though those who use it largely, both abroad and in this country, never experience any such ill effects from it.

There are two qualities of rice, the Carolina, and the East India; the former is sold by the retailers at 5*d.*, and the latter at 3*d.* per lb., although the highest wholesale price of the latter is usually only from 9*s.* 6*d.* to 10*s.* per cwt. It is sold in bags of about 150 lbs. weight, and if a few families would club together for the purchase of a bag of that weight, it would thus not only save expense, but add materially to their comforts, for it would then not cost more than 1*d.* per lb. It is, indeed, advertised at 14*s.* per cwt., which is at the rate of 1½*d.* per lb.; and, as the duty is intended to be reduced, it will be still cheaper. Now, although the Carolina rice is larger in the grain, as well as whiter,

than the East India, and therefore generally preferred, yet it is not at all better for family use, and it may be dressed in various ways with advantage : first premising that, in whatever way it may be cooked, it should always be well washed, and allowed to simmer for a long time by the side of the fire in an earthen vessel, so as to allow it to imbibe the liquor in which it is boiled ; or it may be left in the liquor over night until it becomes soddened. For instance, take a pound of rice, and if you have any of the liquor in which meat has been boiled, put it into just as much as will cover it, for if you put in more the rice will not absorb it. You must also take care to occasionally stir it, and add a little more of the liquor to keep the rice covered. When the grains are becoming swollen, add three or four onions, and, if you have such a thing in your garden as the love-apple, or *tomata*, take also as many of these, leaving them all to stew until tender, and until the liquor has been entirely absorbed ; then mix them all together, and season the mess with pepper and salt, stirring into it a piece of butter. If broth cannot be had, it may be dressed with plain water, and will be found a substantial and pleasant supper, even without the tomatas, though they greatly improve it.

Or as thus :—Cut a quarter of a pound of bacon into pieces with a few onions, thyme, parsley, and peppercorns, boiled in two quarts of water, and, when it boils, put in a pound of clean whole rice, and set the pot by the side of the fire. The rice will swell, and thus imbibing all the water, will become quite soft : it will then weigh nearly five pounds, which is more than the family can consume at one meal, though eaten without either bread or potatoe ; and the cost of either of the above will not exceed 6*d*. Even if plainly boiled into a pudding, without either bacon, onions, or tomatas, and eaten with either a little butter or treacle, the same quantity will be more satisfactory to both the palate and the stomach than a quartern loaf of bread, though not costing half the price.

A much better mode than this is, however, to let it stew in 3 quarts of skim-milk until it becomes quite thick, and sweeten it with sugar or molasses ; or, if you have a Dutch oven, put it into a deep dish, covered with a few thin slices of bread, without eggs, and bake it. Indeed, two-thirds of that quantity, or 2 quarts of milk and $\frac{3}{4}$ lb. of rice, will be found amply sufficient as a meal for four ; and, should any portion be left, it will be as good cold as hot. If the milk be purchased, it will indeed be dearer ; but many benevolent gentlemen, and some farmers, give away a certain quantity of skimmed milk daily to their labourer, than which few charities can be of greater benefit to a family. Even if obliged to buy it, a poor man had better do so than be without it, for in distant country places the price is seldom more

than $\frac{1}{2}d.$, or at the most $1d.$ the quart; but, unfortunately, it is so generally wanted for domestic purposes, that it is not often sold.

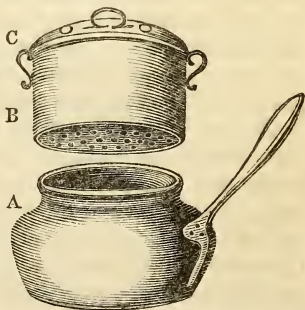
No instruction is necessary for the making of pies and puddings whether of fruit or meat; but we may just remark, that a *meat-pudding* (when a labourer can afford it) is one of the most substantial and savoury dishes that can be brought to a hungry man's table; and that if, instead of putting pie-crust over the meat, you cover it with mashed potatoes, and put it either into the oven or bake it by the side of the fire, it will answer quite as well as paste. In Cornwall there is a common practice among those cottagers who bake at home of making little pasties for the dinners of those who may be working at a distance in the fields. They will last the whole week, and are made of any kind of meat or fruit, rolled up in a paste made of flour and suet or lard. A couple of ounces of bacon, and $\frac{1}{2}$ lb. of raw potatoes, both thinly sliced and slightly seasoned, will be found sufficient for the meal; the pasty can be carried in the man's pocket, but it costs $4d.$, as thus:—

	<i>d.</i>
$\frac{1}{2}$ lb. of flour . . .	1
Suet or lard . . .	1
Potatoes . . .	$0\frac{1}{4}$
$\frac{1}{4}$ lb. of bacon . . .	$1\frac{3}{4}$

Oatmeal is a frequent diet of the Scotch and Irish peasantry, as well as of many of the gentry, among whom it is known as "*porridge, crowdy, and stirabout.*" The preparation is simply to put a handful at a time gradually into a pot of warm water, and a little salt, simmering it over the fire, and keeping it stirred with the other hand, until it becomes as thick as a pudding; or in about ten minutes' time. It may then be eaten with a little treacle, or with a piece of butter put into the centre; but the better way is to eat it with cold milk, taking a spoonful of the stirabout with a mouthful of the milk; for, if boiled in milk, it is not near so good. Fine meal does not answer the purpose, and the coarse-ground "*Scotch oatmeal*" is the best. Now, about $\frac{1}{2}$ lb. of this, along with 3 pints of milk, will make a substantial and a very wholesome breakfast or supper for the family. It is indeed a hearty food, and the cottager who seeks to support his wife and children both frugally and healthfully should never be without it. The price in London is $4d.$ per quart, and the quart weighs nearly $1\frac{3}{4}$ lb.; so, supposing the milk to be bought at $1d.$ the quart, three good meals can thus be got for $8\frac{1}{2}d.$

Potatoes will ever be the peasant's standard vegetable; for, if of good mealy quality, they contain more nutriment than any other root, and three to four pounds are equal in point of nourishment to a pound of the best wheaten bread, besides having the great

advantage of better filling the stomach; but if of a soapy, waxy kind, they are not only deficient in nutriment, but actually unwholesome. They are seldom dressed in any other way than plain boiled, but there are different opinions as to the best mode—some peeling them before, and others after they are boiled. In Lancashire, where they are in general admirably dressed, they are first peeled—which is certainly the cleanest as well as the least wasteful. The large potatoes are then cut into pieces of the same size as the smaller, so that they may boil equally, and they are put into as much cold water as will cover them to within about an inch, but not entirely. Set them upon a moderate fire until they begin to boil, and then throw in a little cold water to prevent them from boiling too suddenly before they are done to the heart. When done soft enough to admit of a fork, then pour the water off; for if it be allowed to remain a moment after the potatoes are done, they will become watery; uncover the pot, and set it at such a distance from the fire as to prevent from burning, yet near enough to keep the potatoes hot and allow their moisture to evaporate; and eat them immediately. If a handful of salt be occasionally thrown into the water, it will be found to add to their flavour; and they should be boiled separately, or at least never mixed into soup when raw, as their juice is not only unpleasant, but thought by many persons to contain some poisonous quality. A good and economical mode of dressing them, when soup, meat, or other vegetables are to be boiled, is to have a large jug fitted to the mouth of the saucepan, and having a tin bottom of a convex, or arched bottom, pierced with holes, so as to allow the steam to ascend from the boiler. By which simple apparatus A will boil the soup; B will steam the potatoes; and C will cover the whole, having a small orifice in the lid to allow the steam to escape, so as to prevent it from falling down upon the potatoes and soddening them. Any ironmonger will make it for a trifle.



In Ireland they make a very excellent dish, which is commonly used by both the rich and poor, as thus:—take any quantity of potatoes and greens, turnip-tops, or spinach, which have been boiled, or are the cold remains of the previous day, for they will be just as good as if boiled on purpose; mash the potatoes under the rolling-pin until they are reduced nearly to powder, then chop the greens as small as possible, and mix both them and the potatoes well together with a minced raw onion; season them

with pepper and salt; add a piece of butter, lard, or kitchen-stuff, and put the whole into the pot to warm, taking care to stir it until ready. This may be eaten without bread, and four to five pounds of good potatoes, together with a good quantity of greens (*not cabbage*) will be found a savoury mess for the family, at the expense of not more than a penny per head, even if the peasant has not a garden to grow his own vegetables.

If, instead of greens, a couple of salt herrings, or three or four pilchards boiled, stripped of their heads, fins, and tail, and shredded into small pieces, be mixed up and dressed in the same manner, either with or without the onion, the mess will be found equally good; and if you have fat enough to fry it in the pan, or if you take the trouble to brown it before the fire, it will be still better. It may also be observed that salt-fish of any sort, if beaten up with potatoes when boiled, goes farther than when eaten separately.

Potatoes may also be *made into cakes*, and baked in a few minutes over the fire upon a flat iron plate, having short legs upon which it is supported, and commonly known among the Irish peasantry as “a griddle.” It is simply done by mashing the boiled potatoes into flour with the rolling-pin, and binding them together either with a small quantity of milk, or a little fat, and flavouring them with a little salt, then rolling the paste out into cakes of a quarter of an inch thick, placing them upon the hot griddle, and turning them when done on one side. Or they may be made in the same manner, though more like bread, by pouring upon the mashed potatoes a moderate quantity of batter made either of wheaten flour or oatmeal and milk, mixing it thoroughly with the paste, and pricking the cakes with a fork to render them light.

On the *mode of making bread* we offer no instruction, except that, when the cottager has got an oven, it should be baked at home, and made of household flour; but this observation may be made, that in former days our forefathers were accustomed to eat rye and barley bread; and throughout the whole of the north of Germany and Poland, though producing abundant crops of wheat, no other kind of bread than that made from rye is generally eaten, yet no peasantry in Europe are more strong and healthy. The appearance of the bread is not indeed so inviting as that of wheat, but the flavour is extremely pleasant, the quality is more nutritious than that made from barley. Now, it is usually calculated that a man, his wife, and two children eat from three to four pounds of bread daily. The price of the quartern loaf of household wheaten bread is at present *eight-pence*; but that of rye can be made for *five-pence*; and, if this were used, it would occasion a saving of about eighteen-pence in the poor man's weekly wages.

In short, *close economy is the very life and existence of a poor man's comforts.* Without it he will run in arrear with every one with whom he deals ; starvation will stare him in the face ; the wretchedness of his wife and children will drive him in despair to the beer-shop ; and that, finally, as a drunkard, a pilferer, and a poacher, to the workhouse ; whereas, if on the Saturday night he finds that by good management he has made both ends meet, without running into debt, he will have the heart-felt satisfaction of providing bread for his children, and perhaps for a worn-out parent who fed him while he was himself yet more helpless ; he will shun the profligate associates of the pot-house ; he will cling to his humble home, and look forward with satisfaction to his evening meal ; his family will be happy, and himself respected in his station ; and if at the close of the week he can lay by a sixpence, he will, by pursuing the same plan, acquire habits of careful industry, which will at length surely render him to a certain degree independent. It can, however, only be done by his having in hand at least a week's wages to the fore ; so as to enable his wife to buy everything for ready money, without having a score at the chandler's shop.

He should, therefore, pinch and screw the family even in the commonest necessities until he gets it ; for, if in debt to the shopkeeper, he will pay for everything at the highest price, and of the worst quality. Neither can it be done unless, besides being of industrious habits, he is a good workman ; for, low as wages now are, yet such is the present competition for employment, that it is to be feared no labourer who is not a superior workman can look for more than a mere subsistence ; and although the price of labour may be higher in many of the mining and manufacturing than in the purely agricultural districts, there is in such places a corresponding increase in the cost of the necessities of life, which deprives the workman of any additional benefit. He should toil early and late to make himself perfect in ploughing, ditching, draining, and every farming practice which he may be called upon to execute. He will then not only have constant employment at the highest wages, but also frequent profitable jobs at task-work ; and if known to be a trustworthy, intelligent fellow, he may look forward to become the bailiff of the farm, with the prospect of one day renting land for himself. This, to be sure, is the work of time, for a good character cannot be acquired in a moment ; but farmers and land-agents are not unobservant of the habits and qualities of those employed under them, and will ever prefer a man on whom they know that dependence can be placed.

If the poor man does this on his part, there can be no doubt that the rich will do theirs. They are the natural guardians of the poor, and they cannot but discover their own advantage in

the conviction that whatever is calculated to improve the health will add to the strength of the labourers who work for them, and thus increase the permanent welfare of the whole body. Every landowner and farmer has it more or less in his own power to contribute to the comforts of the peasantry, and to enable them, by honest industry, to guard themselves from the humiliating prospect of parish relief. Their attention to it tends to foster a kindly feeling between man and man in the different ranks of society, and to encourage in the poor man's breast that wholesome sense of independence, without which he must feel himself degraded in the scale of creation. It can be done by goodnatured advice, and occasional assistance, even without any advance of wages. A small loan of money, to be gradually repaid out of the weekly wages, will go far to put an end to that system of credit which renders him dependent on the village shopkeeper. The adoption of money-payments, instead of allowances in beer, would also be desirable; and, in short, the farmer who stretches forth a helping hand in aid of a sober, industrious servant, will reap his reward not only in his own sense of benevolence, but also in the increased attention of the labourer.

The most anxious wish is entertained by the Royal English Agricultural Society to better by every means in their power the condition of the rural peasantry, as that portion of the community may justly be considered the most peaceable, orderly, and useful of the labouring classes. The allotment system has already done much towards creating a peaceful spirit of social as well as profitable family employment in the occupations of the garden, with increased attachment to home, and, aided by that light of religious education which is now shedding its benign influence over the land, will, it is devoutly hoped, eventually lead to that domestic happiness of which it is the surest foundation.

A plot of ground allotted as a garden around a cottage is, however, far preferable to one placed at a distance; for the cottager's wife is equal to work, and would fain employ herself frequently in her garden, if she had it within her reach. But she cannot leave her infant in its cradle, nor the child crawling upon the floor and requiring constant attention. She is, therefore, deprived of the means of thus assisting her husband in his labours; and even when he returns to his home, how much more pleasant will he find his cot when surrounded by the smiling produce of their toil, than if that be not under their view.

We recommend the little tract on 'Cottage Gardening,' published by Mr. Main, under the superintendence of this Society, to the attention of every cottager; for he will there find, for a penny, every necessary direction regarding the management of his ground and cropping, in the most simple and efficient manner. We only

differ from him on his objecting to fruit-trees; for although we admit that they should not encumber a small garden, yet two or three apple and plum trees afford a pleasant addition to family-fare in the making of a substantial pudding.

There is also one very profitable source of income to a cottager, which is denied to him who is not possessed of a garden at home; that is, the *keeping of bees*, which industrious insects amply repay the trifling care and attention necessary to preserve them. They require no expensive method of treatment; they demand no trouble, and a row of bee-hives will meet a heavy rent, besides affording a grateful luxury to their keeper: but they should be securely guarded from pilferers. A treatise on bees would occupy too much space for this essay; but any man who will inquire the mode adopted by a neighbour who keeps them, may easily learn the method; and if he cannot purchase a hive, he may construct it himself without the least difficulty.

Cobbett's advice, to "grow *mustard* in your own garden," ought not to be neglected; for a square yard of ground will be sufficient; and if you have not a small hand-mill to grind it, it may be pounded in a mortar as wanted for use, and will answer quite as well, if not better, than the trash frequently sold as "Durham."

Vinegar should also be made at home. This can be easily done by having a small runlet, or a large unglazed earthen jar, placed in a warm spot, exposed to the sun during the summer, and near the chimney-corner in the winter, putting into it either a pound or two of treacle and a quart of water, as a foundation, and leaving out the bung, or slightly covering the mouth of the jar, so as to prevent the introduction of dust, but not to exclude the air. Then, whenever you have a few gooseberries and currants, or any fruit of a juicy kind, put a few of their stalks, rind and all, into the vessel, together with any remains which you may occasionally have of beer, and if you have not enough to cover the fruit, add a little warm water. When the cask is full, leave it there until it begins to ferment, which in no great time will render the liquor quite sour; and after it has stood long enough to become clear, it may be then drawn off as vinegar. It may not be strong; but it will be quite as good as that usually sold in the country shops for two or three shillings the gallon, besides thus affording plenty for pickling and the other uses of the family.

In many of our inland counties, although there is a great *scarcity of fuel*, yet the ashes and cinders are often cast out before the cottage-door. Now, instead of this waste, they should be mixed up with an equal quantity of small-coal and some clay to bind them, together with water; then mix the heap into mortar; make that into bricks; and, when dried in the sun, put them at

the back of the fire, where they will soon heat, and form a useful saving of coals and wood.

The foregoing instructions are, however, chiefly addressed to the housewife ; for if it be the husband's business to bring home money, it is hers to see that none of his earnings go foolishly out of it. To attach a man to his home it is necessary that home should have attractions ; and if his wife is a slattern, everything will go wrong ; but if she be industrious, thrifty, and good-tempered, cleanly in her person and her cottage, all will then go right. She will forego tea and gossip ; she will put everything in the neatest order ; her little fire trimmed and her hearth swept up for the reception of her husband on his return from labour. Whatever may have been her cares during the day, she will meet him with the smile of welcome ; the family-meal will close the night in social enjoyment, and he will find as cheerful and as happy a home as if he were the lord of the manor.

X.—*On the Present State of Agricultural Mechanics, and on the Improvement of which the various Implements now in use may be susceptible.* By JOHN MORTON, Jun. Prize Essay.

It is one of the most satisfactory marks of the late revival of agriculture in England, that it has caused inquiries, not only into what formerly excited the greater interest, the breed and management of live stock, but also into every branch of arable farming. It is intended in the following essay on agricultural mechanics—one of the most important of these branches—to describe each implement in succession under separate heads, according to the order in which they are made use of in cultivation.

It is difficult to conceive what causes can have combined to produce the strange variety existing in the construction of implements. Differences in the practice of various districts, handed down from time immemorial, have probably been accompanied by differences in the form of the agricultural machines used. Differences in the soil also of various districts must have had some influence in causing this variety. It will be attempted in the sequel to show how far variations in the form of several implements are required by variations in the nature of the land they are required to work ; at present it is sufficient to observe that the immense variety now existing is certainly unnecessary, and only shows our want of acquaintance with the correct principles of their construction.

Implements may be divided into four classes, following the order of succession in which they are used on the farm :—

I. Implements used in tilling the land and in the cultivation of crops.

II. Implements used in harvesting the crops.

III. Implements used in preparing the crop for market.

IV. Implements used in preparing the crops for food for the stock on the farm.

I. The first class of implements, according to this division, are those employed in bringing the land into a fit state for the reception of the seed, and in keeping it in a proper state of cultivation during the growth of the plant; and the first to be described under this head are the implements used in freeing land from superabundant water, the various descriptions of draining-plough, and the subsoil-plough, their valuable auxiliary. Then having by the use of these implements got our land into such a state that the other implements of tillage may be used with advantage, we shall come to speak of the plough, the harrow, the roller, and the various forms of the grubber or cultivator, with the valuable implements of drill-husbandry allied to them—the horse-hoe and the drill-harrow. Then we shall speak of the various forms of sowing-machines, whether for scattering the seed broadcast or sowing them in drills; and lastly, as connected with every stage of cultivation, the cart and the waggon.

1. *Implements of Drainage.*

In tracing the history of thorough drainage we do not require to go very far back. The practice is, in fact, still in its infancy; certainly, however, no branch of agricultural practice has, in so short a time, effected such strikingly beneficial results as the frequent drain-system.

Drainage was in former times restricted to directing the water of springs into proper channels, and hindering them from forming marshes. In this, great improvement was effected by Mr. Elkington, of Warwickshire, who did not merely apply himself to the confining and conveying away of the water after it had reached the surface, but, by means of boring-tools, probed the ground to the source of the spring, and took the water altogether out of its former course, directing into one channel what had formerly, by springs, overspread a considerable extent.

The removal of the water of springs, which used to stagnate on the soil, was a great good effected, but it was not generally known till Mr. Smith, of Deanston, pointed out the fact that, of the land injured by stagnant water, the great portion is wetted, not by water springing from the land, but by water falling and retained on the surface. The full acknowledgment of this fact will, of course, be followed by the application of the only remedy—that

proposed by Mr. Smith—the frequent-drain system. This consists in cutting parallel drains at intervals varying from a half to one-eighth of a chain, and of proper depth, and in conveying the water from them to a proper outlet by means of a larger main drain, into which they all run.

In the great majority of cases land is such that, in the cutting of drains, the spade, and often the pickaxe, is required; and in all cases the most efficient drainage is that performed by the hand. The ditches, however, in those rare cases where the subsoil is clayey and free from stones, as in alluvial soils, may be cut by an implement which turns out the whole of it, or nearly all of it, at once. The first mention I have seen of such an implement, which, however, seems only to have been applied to the cutting of grips or surface-ditches, is in Mr. Douglas's report of Roxburgh and Selkirkshire, 1813, in which he speaks of "a kind of instrument or plough which cuts and removes a square foot of earth; and with six horses and five men will drain a greater extent in a day than 100 men." This, it seems, did not obtain general use: since, however, Mr. Smith gave such an impulse to the adoption of a system of thorough drainagè, a plough for the purpose of cutting out a trench has been invented by Mr. Mac Ewen, of Blackdub, in the Carse of Stirling, where it is much employed. Though I have seen this implement, I never saw it at work; but it is said to answer admirably on the soft alluvial clay of the Carse, and testimonials have been received by the inventor, which show that by perseverance in its use it has answered well also on the more indurated and stony clays of the hilly land in the neighbourhood.

Great force is required to work this implement; ten or twelve horses, with a man to each pair, are required, besides two men to work the plough. The cost of this, with the tear and wear of the implement, is estimated at 3*l.* 12*s.* per day, viz., the horses at 4*s.* a-day, the men at 2*s.*, and the tear and wear of the plough at 1*s.* per horse. It will cut out 520 roods of 36 yards in a-day, which gives 2*d.* per 36 yards as the cost: this is not one-twelfth part of the cost of digging with the spade. The trench thus formed is of great width; but as the same plough may be applied to replacing the furrow turned out, this does not signify. Before filling in the stones or placing the tiles, a man with a small spade forms a space for them, and corrects any deviations from the uniform fall of the bottom. This space of perhaps 4 or 6 inches in depth, added to 20 or 22 inches, the depth of the furrow turned out, makes the whole depth of the drain rather more than 2 feet. This is one of the most successful of the many attempts which have been made to diminish the expense of cutting drains.

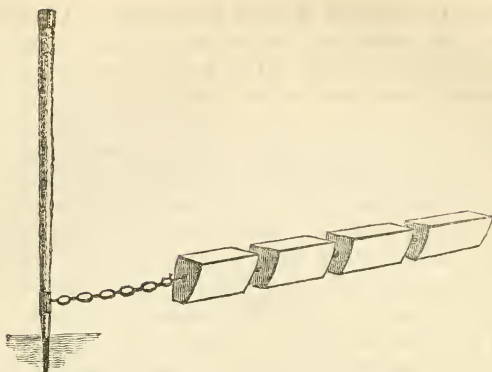
The mole-plough, the action of which consists in making a

bore or tunnel through the soil at the depth of 18 or 20 inches, without removing the surface, is another of these attempts, but is by no means so good a one. It is only in those soils in which such a bore will stand, and not fill up, that this machine can be used, and then the mode of its action necessarily hardens and condenses the clay through which it passes, making it dense and impervious around the pipe which it leaves behind it.

The machine consists of a block of wood or piece of iron of a sugar-loaf form, attached by one or sometimes two narrow but strong uprights, about 2 feet long, to a strong framework of wood, to which the draught-chains are fixed. It is drawn either by a strong force of horses, or by a windlass and chain, which is moved from drain to drain as each is completed. The two uprights necessarily cut through the land above the drain, and so far connects it with the open air; but as they are narrow, the passage formed by them fills up, the sides collapsing as the machine passes.

A series of parallel drains is thus formed at a depth of 18 inches. These are connected with a master-drain, dug with the spade, into which the water from them runs and finds an outlet from the field: when this is filled in, the drainage is complete. Its permanency and efficiency of course depend on the nature of the soil and the subsoil it passes through. Under the most advantageous circumstances, however, it does not last long. This implement has been long in use, it is referred to in many of the county surveys of 1813. The use of the capstan also to draw it along, instead of employing a great number of horses, was then frequent.

A better way of draining, however, is that called clay-draining. A trench 20 inches deep, 2 inches wide at bottom, and 10 inches wide at top, is cut with long narrow spades, which do not require the men using them to descend into the trench. After the trench has been dug a wooden mandril is made use of. It is formed of pieces of wood 6 inches deep, 2 inches wide at bottom, 4 inches wide at top, and from 9 to 12 inches long, hinged together so as to give the whole chain flexibility, and fits the bottom of the ditch to a height of 6 inches. The clay of the subsoil is placed above it, and being wetted, is hammered down above it, and the rest of the soil is then thrown in. The mandril is then drawn along by means of a long pole pointed at one end, to which it is attached by a chain near the pointed end: this pole is made to act as a lever. (See figure.) On being drawn along, more earth is thrown in and hammered down above it, and so the work proceeds. This is more durable than the work performed by the mole-plough. It costs about 14*d.* per chain. Neither of these modes of draining, it is evident, admits of the action of the subsoil-plough above



them : so far from that, they are very apt to be filled up by the treading of the horses in the ordinary cultivation of the land : they are, in fact, suited only for the drainage of pasture-land.

The most efficient drainage, as 'I have said, is that performed by the hand, and in which broken stones or tiles are used ; and when the subsoil-plough is used after it, this will, there is no doubt, prove the most economical also.

2. *Subsoil-Plough.*

We now come to the consideration of the subsoil-plough. This implement, though only lately brought into prominent notice by Mr. Smith, of Deanston, seems to have been used in many districts of England long ago. Thus, in the Report of Lancashire, by Dickson, I find the following notice of the "miner or deep-stirring plough :"—"This is another tool of the plough kind, somewhat similar in its nature, which was introduced into the county nearly about the same period as the trench-plough ('long since,' see p. 157). It simply consists of a ploughshare firmly fixed to a strong beam, by means of a strong sheath and handle, without any mould-board. It is usually drawn by four or more horses, being made to follow, in the furrow, the common plough, so as to penetrate into, loosen, and stir up the undersoil without turning it up, to the depth of from 8 to 12 inches below the tract in which that plough had gone."

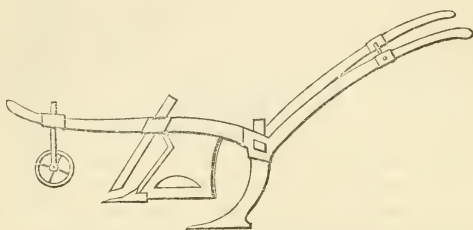
A more accurate description of the way in which the implement is used than is contained in this paragraph of 1813 could not be given now. The use of it did not, however, spread, doubtless because it was unaccompanied by that which must always precede it—thorough drainage ; and it was not till Mr. Smith showed, on his farm at Deanston, the immense advantages following the adoption of both operations together, that either ob-

tained that high place in the practice of good farming which they now hold.

Mr. Smith's subsoil-plough consists of the ordinary framework of a plough, without the mould-board, made strong enough to stand the shocks and the strain to which an implement requiring the force of four or six horses to work it must be subjected. This framework is about 15 feet long. A sole-plate, on which a feather-shaped or pointed sock slips, is attached to it by means of two uprights and a curved coulter. The height of the plough, when held in a working position, from the sole-plate to the beam, is about 22 inches. It is thus enabled to go to a depth of 20 inches. From the furrow side of the sock a spur projects, over which the mass of subsoil cut by the coulter and share is raised and broken, and falls down again. By the action of this spur, and of the whole implement, the subsoil is effectually stirred, without any of it being lifted to the surface. The effect of subsequent deep ploughing, after the action of the air has thus sufficiently meliorated the subsoil, will be beneficial, while without this previous cultivation it would have been injurious. The subsoil-plough requires at least four horses. The draught, in a rather clayey soil, was $11\frac{1}{2}$ cwt., going from 16 to 18 inches deep. The draught of the common plough, which preceded it, and turned out the furrow in which it worked, was about 5 cwt.; so that the work for the horses was about the same in either case. It is found that the wider the furrow is turned out, the more efficient is the operation. In a subsoil ploughing-match, held at Sterling in 1840, it was found that the best work was done by that subsoil-plough which was preceded by the old Scotch plough, which casts a very wide furrow. It is evident that this does not necessarily imply that the subsoil-plough shall pass along a fewer number of furrows in a given width of land than where the furrow is narrower, for the width of the furrow depends not on that of the furrow-slice, but on the width of the plough, which thrusts the furrow-slice from the fast-land. The expense of the operation of subsoil-ploughing is considerable. It varies from 24s. to 30s. per acre, according to the nature of the land; and it is evident that in rough strong land, where the pickaxe is afterwards required to remove the obstructions which the plough has met with, the expense will be much greater than this. This is a statement of the debit side of the farmer's account of subsoil-ploughing. To find the credit side of the account, he must compare his land as it was,—wet or scorched, according to the weather, on which it was wholly dependent,—with his land as it now is after the operation,—free and friable, dry and open;—and he must take the crop he raises now, at less expense, too, than formerly; for the land, being drier, is more easily tilled; and he must compare this crop with that he used to raise on the same land. The difference will pay a very great per centage on the capital he has laid out.

Several attempts have been made to diminish the expense of the operation of subsoil-ploughing. The first of them is by Mr. Pusey. A description of the Charlbury subsoil-plough is given in the 4th part of the 1st vol. of the '*Journal*.' It combines in one implement both the ploughs used in the operation of subsoiling.

It not only stirs the subsoil, but opens the furrow in which the subsoil-plough works. It consists in the attachment of a strong tine, similar to those used in Biddel's scarifier, to the common plough, in a position in which it acts after the furrow-slice has been turned.



[The Charlbury Subsoil Plough.]

This implement, doing all the work, requires, according to an experiment recorded there, less force to work it than the subsoil-plough, doing only one portion of the operation. It cannot, however, be so efficient in thoroughly stirring the subsoil as the original implement. The other attempt at diminishing the expense of subsoil ploughing is by Mr. Armstrong, of Sterlingshire, for which he received premiums from the Sterlingshire Agricultural Society and from the Highland Society. A description of it was given by Mr. Smith, of Deanston, at an agricultural meeting lately, which I transcribe. The inventor has adapted the principle of Mr. Wilkie's turn-wrest plough to Smith's subsoil-plough.

"The general frame-work is that of a subsoil-plough rather under the medium size, and to it is attached a hinged mould-board, similar to the mould-board of Mr. Smith's hill-side or turn-wrest plough. By means of this arrangement the plough can be used for removing the furrow preceding the operation of the subsoil-plough, and, when the furrow has been removed, the mould-board being moved upon its hinges, from its working position, rests over the beam of the plough, whilst the instrument is used for subsoiling in the bottom of the furrow just removed. Thus the operation of removing the furrow and subsoiling can be alternately performed with the same implement, by the same ploughman, and the same team of horses, by a simple movement of the mould-board, which is done in an instant by the hand of the ploughman at each turning. The additional weight of the mould-board serves to keep down the plough whilst subsoiling in difficult ground. The judges consider this implement well contrived, and as being an important boon to small farmers, and as

certain to give great facility to the extension amongst them of the admirable system of subsoil-ploughing."

On the same principle, and similar in its mode of action to the subsoil-plough, is the rackheath-plough, invented by Sir Edward Stracey.

3. *The Plough.*

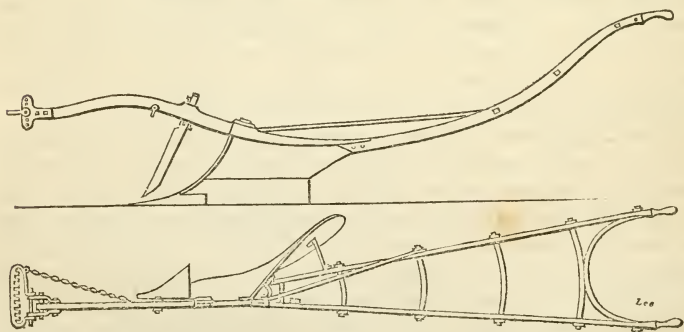
The plough has always been the most important of agricultural implements. Its origin is as ancient as the art of agriculture. In the earlier portion of our world's history it was very simple. Mankind, scattered few and far between, did not then require to make use of the poorer and more unprofitable descriptions of soil, and the rich lands they tilled yielded them ample return, though but very slightly cultivated. This implement, accordingly, as then used, merely scratched the surface of the ground, or stirred it a few inches deep. Since then great alterations have been made in its form. The implement has been made not only to stir the soil, but to turn a sod. This probably took place when experience had taught that the poorer soils, which were at length brought into cultivation, could not be profitably tilled by a mere stirring of the surface. Even now, the form of many of our ploughs shows plainly the origin from whence they sprung. The pointed stick, which was originally used, was, probably, gradually widened out into the form of a cone; and, to render its action efficient, the under part of this cone being cut away, we at once have the rounded breast and primitive appearance of many of our mould-boards. Unless we consider this to be the origin of this form of the mould-board, it is difficult to conceive how experience and practice would lead to the opinion, so manifestly inaccurate, that this is the best form, the one of easiest draught.

Of no implement is there a greater variety than of the plough. There are full-breasted ploughs, and hollow-breasted ploughs; there are wheel and swing ploughs; ploughs with fixed mould-boards, and turn-wrest ploughs; ploughs with two handles, and one-handled ploughs.

The writer of an excellent article "On Ploughs and Ploughing," in the 'Farmer's Magazine' for January, 1841, divides all these into three classes: the Scotch swing-plough; the midland counties plough with one or two wheels; and the turn-wrest plough of some southern districts. The present Scotch plough is entirely different from the plough in general use thirty or forty years ago. There were, indeed, as great a variety in that country then as there are in England now. When, however, this form was introduced, it soon obtained almost universal adoption, and is now the only implement of the kind in use. It is curious that it should not have spread southwards as rapidly as it

did northwards. Its use in England is confined to the border counties. The old Scotch plough was as clumsy as any of the clumsiest of the English swing-ploughs now used. It was not, however, the original of the present swing-plough. The original of Small's ploughs came from Holland or Flanders into Yorkshire, and was thence introduced into Scotland, where it acquired the name of the Rotherham plough. At this time Small, an ingenious mechanic of Berwickshire, became known to J. Renton, Esq., of Launceston in that county, who, perceiving his talents, erected the necessary buildings for an extensive plough factory, and placed him over it. Here Small devoted his energies to the improvement of the Rotherham plough; and the alterations he made on it soon deservedly gave it the name of Small's plough. Small's plough soon drove all the cumbrous implements then made in Scotland out of it, and now it is in universal use. Slight alterations have been made in it, and every ploughwright of eminence has his own form of the mould-board, but they differ but slightly, and Small's is the basis of them all.

Wilkie, one of the best of these makers, obtained and continues to possess, a high degree of celebrity for the excellence of his implements. He has lately constructed a plough to which several different mould-boards are attachable, and this, it will be seen, is the only variety which is required in the form of the plough. The Scotch mould-board is most gradual in the twist it gives to the furrow.

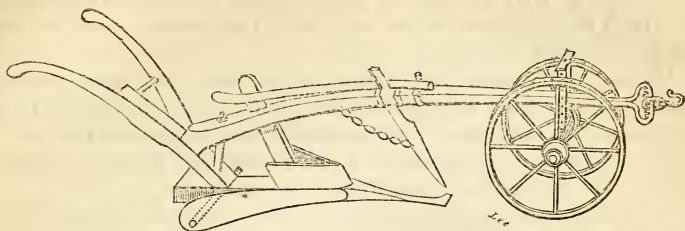


[Clarke's Plough. Scale $\frac{1}{12}$.]

The annexed are two views of the Scotch plough of Clarke, a Stirlingshire ploughwright; they are drawn on a scale of $\frac{1}{12}$ th. It is generally made wholly of iron. Small's first improvement was to substitute iron for wood in the construction of the plough.

The immense variety of wheel-ploughs, as they are used in the midland counties, can better be illustrated by a series of figures

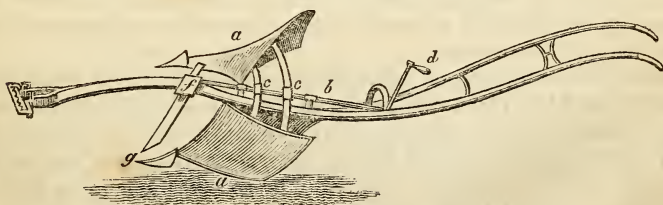
than by detailed description of each, which indeed I am not qualified to give.



[The Kentish Turn-wrest. See 'Penny Cyclopædia.']

The Kentish turn-wrest plough, used for working the clayey and chalky soils of that county and several of the neighbouring counties, is the representation of the third class of plough. It is certainly a most clumsy implement, and its capability of breaking up the stiff lands of those districts is evidently due, not to any peculiar excellence of form, but to its great strength and weight, and the power applied to it. Its form is adapted, not for *cutting* a sod, but rather for *tearing* and forcing it from the land. The annexed figure represents it in its original and most general form, which has been much improved by Messrs. Ransome. The share is a broad chisel-edge, and the coulter, by means of an elastic stick, which is made to press against one side or other of that part of it above the beam, is directed and kept on that side of it next the unploughed land. The plan of turn-wrest ploughing, turning all the sods one way and avoiding all furrows, is necessary on the steep hill-sides, and is much the best way of cultivating perfectly dry land.

Mr. Smith, of Deanston, now always uses the turn-wrest plough; and the regular and uniform appearance of the fields at Deanston is beautiful. The maker of this turn-wrest plough is Wilkie; the annexed is a drawing of it.



[Wilkie's Turnwrest, or Hill-side Plough.]

Each of the two mould-boards is attached to the rod *b* by two bands of iron *c c*, by which, with the end of the handle *d*, they are

alternately raised or depressed; while the one is in a working position, the other is carried above. The rod *b*, extending to the coulter at *f*, in moving the mould-board moves also the coulter one inch at the point, so as to give it the proper position with the point of the sock at *g*.

Having thus seen the immense variety that exists among ploughs, it may be well, before inquiring into what ought to be the form of the plough, to inquire what it is required to do.

The objects in ploughing are three; and the mode of ploughing must of course be varied to suit the object.

The furrow is opened up, and the furrow-slice is turned,

1. That the after-action of the harrow in covering the seed may be facilitated, and

2. That a new surface of mould may be exposed, or

3. That anything laid on the surface may be buried.

Now, it is evident that these being the objects of ploughing, they cannot vary so much as to require that immense variety of implements which exists. The position in which the furrow-slice will lie does not depend on the plough, except in so far as its form and dimensions are regulated by that implement. When once the form of a series of slices which are to rest on one another is fixed on, then their position is also determined. The form of the furrow-slice then, as it regulates its after position, must be regulated according to the work to be done.

First, then, with regard to the first object of ploughing, the preparation of the ground for the after-action of the harrow. It is demonstrable that when the angle of inclination of the furrow-slice is 45° , there is a greater quantity of earth raised above the level in the form of ribs than under any other circumstance. Now, as the action of the harrow will tear this lip or series of lips down, the more earth there is contained in them the greater will be the depth of loose mould thus formed. Now it is also demonstrable that this position of the furrow-slice can only be obtained when, the breadth of the furrow-slice being 10 inches, the depth is about 7. Here, then, we have at once the form and position of the sod, by the adoption of which we shall derive the greatest advantage from a subsequent harrowing.

The second object of ploughing being to expose a fresh surface of mould to the action of the air, it is evidently important to know under what circumstances the greatest amount of surface will be exposed. It will be at once seen from the subjoined solution of the question,* that this is the case when, as before, the width being 10 inches, the depth of the sod is 7 inches. It will then lie at an angle of 45° , and the width of the portion on

* See Appendix.

either side of it will be equal. This position, then, has the neatest appearance, while at the same time it answers two most important purposes of ploughing.

And now with respect to the third object of ploughing,—it is obvious that in order to bury anything effectually, the furrow-slice should as nearly as possible be turned upside down.

This will be the case when the breadth is great in proportion to the depth, and it will therefore be most perfectly answered when, the breadth being fixed on, the land is ploughed very shallow. Shallow ploughing too is what experience points out as proper when covering manure; and it is evident that, provided the manure have sufficient earth above it to absorb the products of its fermentation, its nearness to the surface, that its decomposition may rapidly take place, is an advantage.

Having now seen what a plough is required to do, we have to consider the form of the implement which shall best effect these objects; and as a consequence of what we have already said, we must first ascertain what form of plough will do the best work, and then see how this form may be altered to diminish the draught.

A plough consists of three parts:—

- 1st. The frame-work;
- 2nd. The cutting parts;
- 3rd. The mould-board.

1. *The Frame-work.*

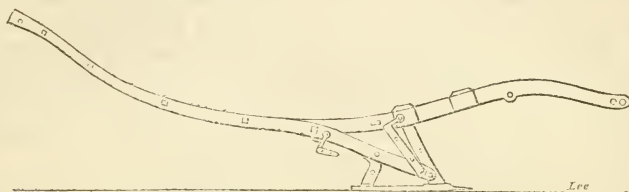
The frame-work of the plough must be regulated by the work to be done, so far as strength to sustain the tear and wear and the shocks of the roughest work is considered; but its dimensions, the length of the beam and the length of the stilts or handles, as they only affect or regulate the power which the man or the horse has over the implement, need not vary with the work to be performed. These are wholly independent of the consistence of the land to be ploughed, or of the form of the furrow-slice, which both vary, and their dimension may therefore be fixed; and amidst the immense variety of forms of the plough, it is satisfactory to know that this point, one so much affecting the appearance of the implement, need not vary.

The length of the beam in some degree affects the power of the horse over the implement. If it be long, it is evident that the straightness of the furrow will be less affected by any deviation of the horse from the straight path, and the motion of the implement will be more regular. This, however, is as well ensured by lengthening the draught-chain as by lengthening the beam.

The longer the handles of the plough, and the shorter the beam in proportion, the more power will the man have over his implement. There are, however, limits to both of these points, which convenience in the length of the implement impose. Very excellent dimensions are

those of the Scotch ploughs of Clarke and Fergusson, plough-makers of Stirlingshire (see woodcut). The length of the beam is in these ploughs 3 feet, and that of the handles is $5\frac{1}{2}$ feet; that of the whole plough is $10\frac{1}{4}$ feet, which leaves 21 inches for that part of the framework to which the body of the plough is attached.

The following is a sketch of the mere frame-work of their plough, on a scale of $\frac{1}{12}$ th:—



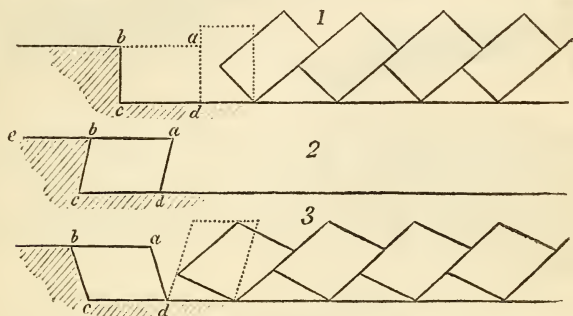
[Frame-work of Clark's Plough. Scale $\frac{1}{12}$ th.]

2. *The Cutting Parts.*

The cutting parts of the plough are, the share, which cuts horizontally the bottom of the slice, and the coulter, which cuts it vertically from the fast land, of which it forms part. It is evident that these should cut it perfectly.

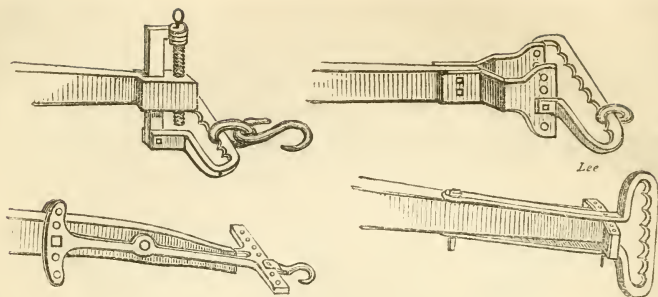
There should be no tearing when the mould-board begins to work. Any tearing must require an otherwise unnecessary exertion of power, and will increase the draught. In some districts an invention has been tried which does away altogether with the attachment of the coulter to the beam of the plough, and provides in its place a projecting edge, standing up from the sock on the vertical plane of the side of the plough, but inclining backwards towards the plough, at a considerable angle. This, of course, ensured the perfect cutting of the sod; but it was found in practice that it encountered more obstruction, and was more liable to bend, or, if made of cast-metal, to break, than the common arrangement for the purpose: it was, therefore, abandoned. It is evident also that the sides of the furrow-slice should be square; that the section of the sod should be rectangular. It is obvious that as the furrow-slice, supposing in the annexed figures $a b c d$ to be a section of it, must turn around the point d , if the angle $b c d$ is an acute angle, it will be held fast, and must either be thrust aside beyond the reach of the projecting ledge $e b c$, or forced through it; either of these takes place under a waste of power. In order, then, to be capable of turning, it must be either rectangular, or the angle $b c d$ must be obtuse. Now there are two advantages connected with its being a right angle. A greater amount of surface will be exposed: compare the two annexed figures (1 and 3). It is evident that, other things being equal, the smaller the angle the greater will be the surface exposed. A greater depth of mould will also be torn down by the harrows, a greater quantity of earth being raised above the general level in the form of ribs,

when the angle is acute, than when it is obtuse. The relative position of the share and the coulter must then be such that they may cut a square-cornered sod. With regard to their actual position in the plough, it is obvious that the more inclined they are to their work, the more easily will it be accomplished. The cut will be more gradual—less abrupt. They should, therefore, be as much inclined to their work as is consistent with a convenient form of the plough.



Now it is evident that, though it may be necessary, when altering the dimensions of your furrow-slice, making the plough go deeper or shallower, or when going from one description of soil to another, as from a clayey to a strong soil, to alter the *position* of the share or of the coulter; yet there can, under no circumstances, be any necessity for an alteration in the *form* of those parts of the plough. Here, then, is another part of the plough which may be constant. We shall find that of all the parts of the plough the mould-board alone will require to vary with the work to be done. There should, however, be a means of altering the position of the coulter; and this is one of the reasons of the failure of that which, as I have said, has been tried instead of it.

There are other means of regulating the position of the plough, according to the nature of its work, which should, perhaps, have been mentioned when the framework of the plough was described. It is evident that the line drawn from the horses' shoulders, through the point of attachment of the draught-chains to the plough, ought, if lengthened, to pass through the centre of the resistance met with by the plough at work. Should it be otherwise—should the line so lengthened strike the mould-board at a point higher, for instance, than the centre of resistance, then the effect of the draught will be to pull the plough over, and sink the point of the share, till the implement, by increasing the depth of the land ploughed, has raised the centre of resistance higher up the mould-board. Should it strike the mould-board to the right or left of this centre, then the plough in the same manner, in order that this centre may be brought into the line of draught, will be forced to take a greater or less width of land. This is the way in which the means act which are adopted for altering the dimensions of the furrow-slice.



The bridle of the plough admits of the attachment of the draught-chain to the plough being shifted to the right or left; and so it enables the ploughman to increase or diminish the width of his furrow; and the bridle, by means of a screw or otherwise (see annexed figures), may be elevated or depressed, and so the depth of the furrow may be increased or diminished.*

3. *The Mould-Board.*

We now come to the consideration of the third portion of the plough, the mould-board. This, we shall find, is the only portion which requires to be varied; and even in this single point it is questionable how far economy would require a variety of forms.

In inquiring what is the proper form of the mould-board, the propriety of first making an implement to do perfect work, and then altering it to diminish the power required to work it, ought to be attended to here more than it has ever been before; for Mr. Pusey's experiments have shown how small a portion of the draught is due to the friction of the earth against the mould-board, and how large a portion is occasioned by the weight of the plough as it runs along the bottom of the furrow. If, then, we can make a mould-board which answers all our expectations, in the way of the excellence of the work it performs, care should be taken, in altering its form, merely to diminish the force required to work it; for by so doing we can at best make but a slight variation in that which is but a small portion of the draught. With regard to the position of the mould-board, it should not encroach on the cutting parts of the plough. The furrow-slice should be perfectly cut before any attempt is made to raise and turn it into its ultimate position.

* There is another and very simple way of altering the depth to which the plough runs; and this is by changing the position of the back-band. It will be seen that by the action of this part of the harness a portion of the draught is thrown on the back of the horse, and only a portion of it remains on its shoulders. By shifting the back-band nearer to the plough, we increase the ascent of the line of draught, and of course tend to raise the point of the plough, make it work shallower; and by placing it nearer the shoulders of the animal, the plough is allowed to go deeper.

I do not know what portion of the draught of the plough is due to the mere cutting of the furrow-slice; but it is evident that the tearing and breaking of the slice occasioned by the abrupt rise of the mould-board in many ploughs, before it is properly cut, must greatly increase it.

The mould-board, besides being most gradual in its rise from the share, must terminate in such a manner that the furrow-slice, even supposing it to be cut of the proper dimensions, shall not merely drop off it into its ultimate position, but that it shall be pressed into its proper place.* It should be twisted over so as to incline from the plough at an angle of 45° where it terminates.

In the construction of the mould-board there are two points to attend to, the length and the nature of the curve.

Both of these have hitherto been determined merely by experience. It is, however, evidently a subject capable of mathematical solution.

With regard to the first of them, the mould-board may be divided into two parts,—first, that between the share and backwards, till by its action the sod becomes vertical; and that between this point and backwards, till the turf by its action assumes its ultimate position. Now, as the proper length of the mould-board is that which receives least friction in turning the turf, it is obvious that the circumstances on which that length depends vary in the two portions into which the mould-board is divided.

There are two different descriptions of pressure on the mould-board, by each of which, of course, friction is produced: that arising from the mere weight, and that arising from the twist of the turf. It is obvious that it is the first portion only of the mould-board on which *both* these forces act. The hinder part of it cannot be acted on by the weight of the turf. It is only the force required to twist the turf that will produce friction on this part of the mould-board; and here, after the turf has been forced over to a certain degree, its own weight will tend to twist it, and so assist the action of the mould-board.

If only the force of torsion in the sod acted on the mould-board, the more gradual the twist, and the longer the mould-board, the less force would be exerted to overcome it. The longer, then, the hinder part of the mould-board is, the less force will be required to overcome the force which acts on it. The only limit to the length of the hinder part of the mould-board, then, is that of convenience in the form of the implement. There is, however, a limit to the length of the first and more important portion of this part of the plough, which is imposed in another way. It has been said, that if torsion were the only force acting on it, the longer the mould-board was made, the more easily would it overcome this force. There is, however, besides this, the force of gravity acting on the mass of the furrow lying on the mould-board, and the less the weight of the turf the more easily, of course, will this be overcome. The shorter, then, the first part of the mould-board is, according to this view, the less force will be required to work it, since there will be a less

* This is particularly necessary in ploughing turf, when it is difficult to bury the sward, unless the mould-board, by a pressure on the upper edge of the sod, tend perfectly to turn it over.

weight of turf lying on it the shorter it is.* There is, then, a proper dimension somewhere between the shortness thus shown to be best and the length which according to the other view is best, in which, each kind of force being taken into consideration, the sum of the forces required to overcome each is a minimum. In order to ascertain this we require the knowledge of several facts—such as the nature of the twist of the least friction, the friction of soils of different kinds on iron, and the force of what may be called *anti-torsion* in sods of different forms and kinds of soil. If these were known, the question might be placed in such a form as would admit of a mathematical solution.

For all practical purposes, I conceive that a sufficiently accurate form of the mould-board might be obtained by taking a model of the twisted surface of a turf turned over forcibly into the position into which the action of a good plough would turn it. If, for instance, a turf of proper dimensions be cut, and left attached at its *extremity only* to the fast-land—and if at a distance from this point of fixture, equal to the length of the proposed mould-board, it be taken hold of and turned over, first into a vertical position, and then into its ultimate position, 45° beyond the vertical—it is conceived that the surface which it would present would be that of a very excellent mould-board; one, at any rate, approximating to that of least resistance. It is evident that this form would be very gradual in its rise, and nowhere abrupt in the twist which it would give to the sod; and it is evident that it would nowhere be full-breasted.

Before leaving the subject of the plough, a word or two must be said on the question of wheel and swing ploughs.

It is evident that unless the wheel can be proved to be an advantage, it is a disadvantage, as it increases the complexity of the instrument.

The most that can be said for the wheel is, that on flat ground it keeps the furrow-slice of uniform depth. Now any irregularity in this matter must be owing to one of two causes—either to a faulty workman or to an imperfect arrangement of the draught-chains on the bridle of the plough; and neither of these things can justly be brought forward to justify any alteration or addition to the plough, for both can be remedied without it. If this be the only defence of it where the ground is dry and flat, what can be said in its favour where it is irregular and wet? The wheel cannot diminish the draught of the plough by lessening the pressure of the implement on the furrow, which has been shown to be the source of the greater part of the friction. If there were one wheel behind and another before the plough, they might have this effect; but this would be too great a complication of the implement.

However, in Stirlingshire, they have ploughs which rest not on the sole-plate, but on a small wheel below the mould-board, which is said to diminish the draught considerably. This, however, where the land is wet, soon clogs, and it thus increases the draught. The remark made by a practical man on the subject, when the Norfolk wheel-plough was

* In the Report, however, of the Judges of Implements at Liverpool, Appendix of Part VII., it will be seen that, of the ploughs tried there, those which had wheels were almost invariably the lightest in draught.—W. MILES.

brought into Berwickshire, is very applicable:—"I believe it is not found universally applicable in grounds containing irregularities of surface and numerous stones, both of which are apt to force it, by encountering the wheels, from its proper direction. Besides, I am apt to believe that the chief use of the wheels, in favourable soils, is to relieve the ploughman from attention and labour, by adding considerably to the draught of the horses."

4. *The Harrow.*

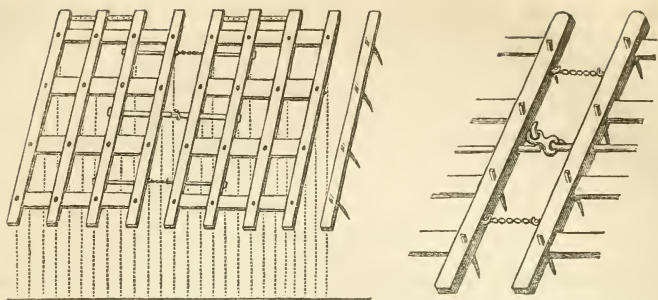
In describing this implement I shall follow the rule I have already imposed on myself, first considering its object and use, and then pointing out what form best answers the purpose intended.

The harrow is required not merely to break the surface clods of rough ploughed land, nor to gather weeds out of it, but a great part of its value also depends on its power of loosening the surface of the soil, and thus allowing the air access to the roots of the plants growing on it, and to the manure lying in it. This is evidently the case from the advantage, frequently most marked, that attends the use of this implement, in spring, over young wheat or corn of any kind. A harrowing in such a case, which would appear most likely to destroy the young plants, is found to cause them to sprout and shoot out with increased vigour. This is especially the case on those soils which are termed *sleepy*, from their tendency to run together after rain, and thus to form a surface almost impervious to air. The harrow is used for three purposes,—first, to break the surface-clods, and reduce the surface of ploughed land; secondly, to gather together and shake out the weeds that are in the soil; thirdly, to cover the seed.

For the last purpose a lighter implement is used than for the former, and the teeth are nearer together.

The common form of the harrow, it is evident, is not a good form; the teeth are closest together in the front part of the implement, and the distance between them widens towards the end of the machine. Now, if it be used to reduce a rough surface—if there is to be any irregularity in the distance of the teeth—they should be nearer towards the back part of the machine; for the clods of earth will be partially broken by the front teeth, and will thus be more efficiently acted on by those behind. It is evidently incorrect to have the teeth closest where the earth is roughest, and farthest apart where it is finest.

The best form of the harrow is the rhomboidal, with the teeth at equal distance throughout. A pair, when hinged together, gives sufficient work for a pair of horses. It is this form alone which ensures that all the teeth shall work in different paths, and that thus the whole of the ground shall be uniformly stirred and broken: a consideration of the annexed figure will make this appear.



[Rhomboidal Harrows.]

In many districts the harrow is used not merely to reduce the surface of ploughed land by tearing down the lip of the furrow, but to stir and lift the furrow-slice to its whole depth. This is not the proper office of the harrow; it should be done by the grubber. The use of heavy drags for this purpose, and the application of great power to work them (I have frequently seen teams of six and eight oxen drawing a single heavy harrow or drag), cannot be economical; it would be much cheaper to use an implement for the purpose manageable by two horses. The grubber, or cultivator, presently to be described, is such an implement.

Though, however, the harrow should not be employed to stir the whole depth of the furrow, it should stir it *perfectly* to the depth to which it goes, and for this purpose it is well to give the teeth a slight inclination forwards, that they may have a sufficient hold of the ground. Their length should be just the depth to which they are intended to go (4 or 5 inches is sufficiently long), and they should not be fastened in by being riveted into a plate of iron screwed on to the beams of the harrows; but they should be slightly of a wedge-shape, that, whenever they get loose, they may be fixed by merely driving them in with a hammer. The tines should, for this purpose, project somewhat above the beam or spar through which they pass; and thus, when the working part becomes worn, it may be lengthened by driving them farther in.

There is another advantage in having the tines of the harrow short: the surface of the land is much more perfectly reduced by it when the frame-work actually lies and rubs along the ground, than when it rests on twenty or thirty long tines, as it does in the long-toothed drags. The implement thus combines the properties both of a roller and a harrow.

The rhomboidal form of the harrows, which ensures that the teeth shall all proceed in different paths, is the best form for all the three purposes to which the implement is applied. It is best for reducing a rough surface, for gathering and shaking out weeds, and it is best for covering the seeds. For the latter purpose a lighter harrow with a greater number of teeth may be used, for the land is generally reduced

to a good tilth before the seed is sown; and the implement has not to contend with any irregularity or roughness in the surface.

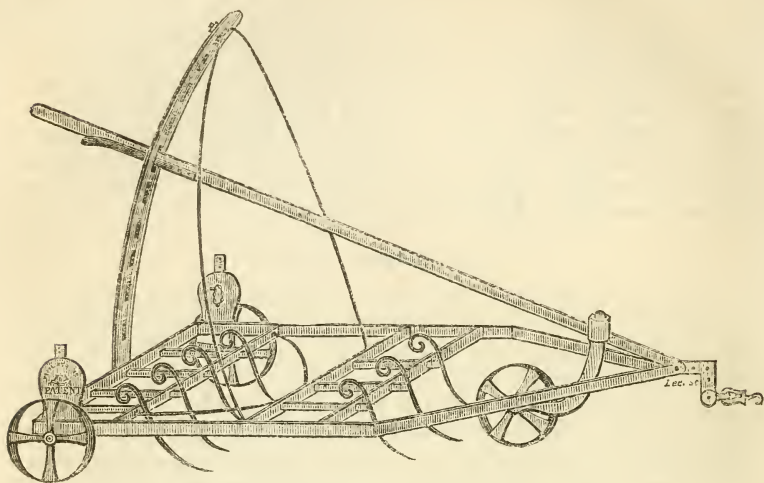
There is one other point to be attended to in the construction of this implement; and that is, the joint or mode of connection between the two portions of which it is composed. This joint should be such as to allow of free and irregular motion in the two parts of the implement; at the same time that it effectually hinders any chance of the one part becoming interlocked with or riding, as it is termed, on the other. The above figure represents a good description of joint; it allows of great irregularity in the motion of the implement; while the double joint in the middle, with the chain at either end, hinders every chance of the one part becoming interlocked with the other.

5. *The Grubber or Scurifier.*

The next implement we have to consider is the grubber or cultivator. The action of this is somewhat similar in principle to that of the harrow, but it is much more perfect. Land is frequently worked with this implement without the use of the plough at all; and this perhaps is the most efficient way of cultivating land off which turnips have been eaten, and preparing it for the barley-seed. The manure left on the ground by the sheep thus still remains near the surface; it is not buried at the depth to which it would be turned over, had the land been cultivated by the plough as deep as it is by the grubber. There is no implement whose action leaves the ground in such a healthy state as this. The teeth tend to clear off weeds, and at the same time to lift and loosen the soil in the most perfect manner.

The first grubber of any note, though before that there had been many an implement of the kind employed, was Finlayson's. It consists of a frame-work which is supported by three wheels, one in front and two behind. In this frame-work there are two rows of teeth; the hindmost row has one more than the front row; and the front teeth are placed opposite the centres of the spaces between those behind them. The consequence of this is, that, while the distance between two teeth in any one of the rows is 1 foot, yet the distance between any two adjacent paths of the teeth through the ground is only 6 inches, for the paths of the front teeth lie between those of those behind. The frame is raised or lowered by means of a lever, which acts on the projecting-bar or crank by which the front wheel is attached to the frame, and gives it a less or a greater degree of inclination; thus letting the machine into the ground or raising it out. This lever is managed by the driver behind the machine. There is, however, no simple means of raising the back part of this machine. It is necessary to fix on the depth you are to work it before you commence work in the day, and set the implement accordingly. The means of doing this consists of a pierced vertical bar which connects the frame-work with each of the wheels, and to which the frame-work is attached by means of a pin. If it be too high, the pin must be lowered; and *vice versa*.

The characteristic feature of this implement, however, is the form of its teeth (see annexed figure). This form is calculated to hinder



[Finlayson's Patent Harrow.]

clogging. Earth full of couch or other weeds coming against it will not stop there, but will rise over the tooth, and fall down on either side, the earth below and the weeds above, on the surface of the land. The faults of this machine are three: 1st. The wheels are always made too small, and the frame is too near the ground, so that in working rough land this clogging takes place in spite of the excellent form of the teeth. 2ndly. The clogging takes place also from another cause. It will be seen that the distance between any two adjacent teeth, according to the arrangement in this machine, is only double of the distance between the paths of the teeth—only 1 foot. Rough, cloddy, and couchy ground will thus soon stop the machine. This may be remedied by a different arrangement, as that in the annexed figure for instance, where the distance between any two teeth is four times that of the space between any two adjacent paths of the teeth in the ground. 3rdly. There are no simple means of lifting the machine wholly out of the ground: the front part may be raised, but the hind part remains.

Kirkwood's grubber, an improvement on Finlayson's, was intended to remedy some of these faults. For the third one he had a very neat remedy, which is best understood by the drawing which represents the frame-work in two different portions, depending on the degree to which the handles are depressed. (See p. 98, Low's 'Practical Agriculture.') It will be seen that the frame-work is lifted partially out of the ground by this means, both ends being raised at once by depressing the handle. In this machine the 2nd fault is also remedied by an arrangement of the teeth, such as that represented in the annexed figure. It will be seen that the distance between any two teeth is much more than twice the

distance between the paths of the teeth through the ground. Kirkwood, however, abandoned Finlayson's form of the tooth, and substituted one such as that represented in page 123 ; and in his machine the first fault of Finlayson's grubber remains in full force,—the frame-work is too near the ground.

Biddell's scarifier is another implement of this class, much stronger and more clumsy: the frame-work* is similar in form to Finlayson's, the teeth as before being arranged in two rows right across the direction of the path of the machine. It is supported on two large wheels behind, and two small ones in front, by which it is raised 20 inches off the ground, much higher than in Finlayson's. There is, above the machine, a complicated apparatus for lifting it out of the ground. The front part is raised by one lever, and the hinder part by another. The form of the tooth has nothing to recommend it: it is necessarily strong and is attached to the frame-work by bolts: to this tooth either a chisel-edge or a duck-foot may be attached; the one being intended to stir the ground merely, and the other to pare its surface. This machine, from its height off the ground and its great strength, is well calculated to work very rough and couchy land. If, however, the ground is damp when the paring-teeth are used, it is impossible to work it, as it immediately clogs. The whole of the machine is of cast-iron, and the teeth are therefore liable to break in stony ground. Four horses are required to work this machine; it is made nine teeth wide = 4 feet 6 inches; five teeth in the back row and four in the front.

Another implement, a very great improvement on Finlayson's harrow, has been put forth by Scoular of Haddington, who supplies them there at 7*l.* each. The form of the frame-work, the form of the teeth, the arrangement of the teeth, and the height of the frame-work, are however the same, still faulty. The improvement consists in a simple means of raising or lowering the frame-work altogether, and of keeping it at any one depth. It will be understood from the annexed figures, which give a side-view and a ground-plan. It is much simpler than Kirkwood's, and possesses, by means of the notched upright, a very simple method of keeping the machine at one depth; the lever or handle by which it is raised is merely fixed in one of these notches: this is effected in Kirkwood's grubber in a complicated manner. Finlayson's, Kirkwood's, and Scoular's are wholly wrought-iron, except, of course, the wheels. Now taking Scoular's as the best of the four for general purposes—and here I may say, that having only five teeth, and working a width of 3 feet, it is perfectly manageable by two horses—if we first take Scoular's machine and point out all its faults, we shall see how these have been remedied in a machine, the invention of the managers of Lord Ducie's Iron-Works at Uley, in Gloucestershire.

1st. The wheels are too small; the frame-work is greatly too near to the ground.

2nd. The teeth, being in two rows right across the path of the machine, are only twice the distance from one another that exists between any two adjacent paths or ruts made by them in the ground.

* See Journal, vol. i., p. 357.

3rd. The teeth being in two rows, there is necessarily a tendency in the bars to which they are fixed to twist, for there is not the strain of one only, but of three teeth, all acting on one bar, tending to twist it.

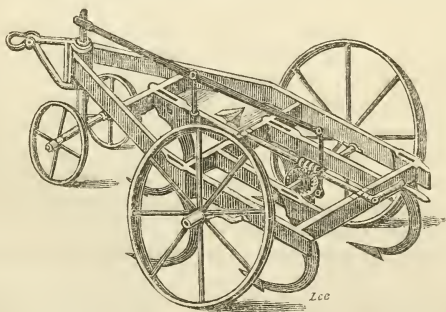
4th. The teeth, though of a good form with regard to their general figure, are not good, if we judge of their strength by their section. This is broader than it is thick; whereas, to stand the great strain placed on them when at work, it should be much thicker than wide. This fault occasions, when the machine is at work, an almost constant recurrence to the smith's shop, the teeth becoming bent.

5th. The whole machine, being of wrought-iron, is expensive.

6th. Although the mode in which the implement is raised out of the ground answers the purpose perfectly, and is beautifully simple, yet it is difficult to manage. It is as much as a man can do to lift it out of the ground at the end of the field, when it is at work. And the difficulty is due in part to this circumstance: it will be observed that the cranks by which the hind wheels and front wheels are attached to the machine all lie behind their points of attachment,—they incline from the horses. Now, in consequence of this, in raising the machine, it is evidently by the action of the lever pulled towards the driver—pulled backwards, and thus in lifting it out of the ground the man has not only the mere weight of the implement to lift, but he has to overcome the whole force of the horses which pull it forward, and thus tend to keep it in the ground. These points, then, require alteration, and at the same time an implement was required which should be as efficient and as easily drawn.

With regard to the first point, the Uley Cultivator rests on four wheels; the front ones being 18 inches in diameter, and the hind ones 3 feet 4 inches in diameter. From the front ones rises an iron rod, having a circular section which passes through the point or nose of the frame-work; the hindmost ones rest on cranks on an axle which runs straight through the frame-work: the frame-work is thus 20 inches off the ground.

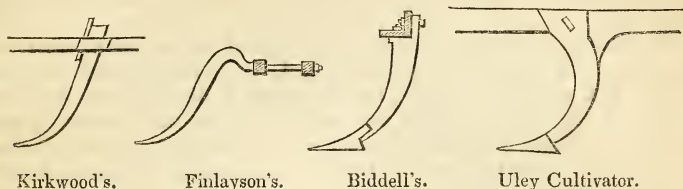
2nd. The teeth are not placed in rows, but are arranged as in the annexed figure (p. 16), and somewhat similar to the arrangement in



[Lord Ducie's Cultivator.]

Kirkwood's grubber. The space between each is thus 2 feet—twice that of Scoular's—while the distance between the paths of each is only

6 inches, the same as in Scoular's. On the points of these teeth, either chisel-shaped or duck-foot or triangular edges for paring are slipped, the form of the tooth on which they slip being such as to hinder these teeth from slipping round. This, with the form of the teeth, is represented in the figure; the teeth for paring are much more pointed



than those of Biddell's, with which they are compared in the annexed figure. The implement has been tried for paring as well as for stirring, and is found to move the whole surface of the ground most perfectly.

3rd. The frame-work does not, as in Finlayson's barrow, consist of a series of cross-bars, into two of which the teeth are fixed in two rows, but it is as in the annexed figure; each tooth having its own bar, to which it is affixed, and not being attached in a direction across the bar, but in the direction of its length, so that any strain on it cannot tend to twist it.

4th. The tooth is not of the same form as Finlayson's, but it has, as Finlayson's, a self-cleaning form. This will be understood from the figure of it given above. It will be seen that the rise for the first five inches is most gradual, and that any couchy earth or clods coming against it will not be stopped by it and clog it, but will rise and tumble over, and fall aside, and so pass by. This, with the height of the frame mentioned in No. 1, and the distance between the teeth, spoken of in No. 2, hinders any possibility of the machine being clogged in fast-land.

5th. The machine is partly cast-iron and partly wrought; and thus while the liability of Biddell's to break is avoided, the advantage of having the cheapness of cast-metal is partly ensured. The sections of the teeth, given in a figure above, show that they are strong enough. Their strength is increased by having an abutment on the frame, against which they rest. The manner in which they are fixed to the frame is also such as to increase their strength. They are made slightly taper at the place where they are keyed in, so that a blow of the hammer makes them fit perfectly accurately to the frame. They are not fixed by wedges, as the coulter of a plough, but by a key which passes through the frame, through both the mortice and tenon, and thus holds them fast.

6th. The mode in which it is raised out of the ground, and the plan by which its depth is regulated, is an invention of Mr. Clyburn, of Uley Works. The ease by which the operation is performed is greater, and the complication of Biddell's scarifier is avoided, while the regularity and parallelism of the motion of the frame-work, as it is raised or lowered, is as perfect as in Scoular's or Kirkwood's.

The hinder part of the machine is, as in Scoular's implement, raised by increasing the inclination of the cranks which attach the hind-wheels

to the frame. In this, however, instead of inclining backwards, and thus requiring, on lifting the machine, an exertion of force, as we before explained, against the whole pull of the horses, the crank is thrown forward in exactly the other way; and thus the whole force of the horses, instead of being exerted against the effort of the driver to raise the implement out of the ground, is actually exerted in assisting him to do so.

The front part of the machine is not raised in the same way as the hinder part, by a crank on the front wheel, but it slips up and down the vertical pole attached to them, and is raised in the following way: the cranks of the hinder wheels are attached to an axle, which passes through the frame, and thus supports it. On this axle a toothed wheel is fixed: this toothed wheel is worked by an endless screw on a shaft, which also works in the frame of the machine. This shaft working by means of this endless screw, a toothed wheel on the axle across the implement is necessarily parallel to the length of the machine, and is turned by means of a crank-handle above. Turning this handle round in one direction, it is evident that the axle on which the toothed wheel is fixed will be turned round, and the crank of the hind wheels raised, and thus the frame brought nearer the surface of the ground, the teeth let deeper into it; by turning the handle the other way, the hind part of the machine is raised.

In order to get the front part of the machine raised and lowered exactly as the hinder part of it, the following simple method is adopted: on the axle of the hinder wheels a crank is fixed, attached for greater simplicity to the pinion before mentioned. It is the same length as the crank of the hind wheels; when, therefore, the pinion is turned round, these wheels being by this crank raised, that is, the frame being lowered, say 2 inches, the extremity of this crank is lowered 4 inches.* From the crank a vertical rod rises, which is attached to one end of a lever resting at the other end on the vertical rod at the front of the machine, and attached exactly at the middle by means of a rod of iron to the framework of the implement. When, therefore, the point of the crank is lowered 4 inches, the hindmost extremity of the lever is also lowered 4 inches, and, as it rests on the top of the vertical rod at the other end, it depresses the rod in the middle and the frame-work attached to it exactly 2 inches, the same as the hind part of it. The perfect parallelism of its motion is thus ensured, while the mode of lifting it requires but a small exertion of force. The implement is altogether about 6 cwt. in weight. It is supplied at Uley at prices varying according to the size, weight, &c. at which it is ordered, certain forms of the implement being intended for two horses and others for four. Before leaving this subject I wish to say a word which might perhaps have been more properly placed in the account of the plough.

The looseness in which the use of this implement leaves the land is, in every case, except when dry weather is anticipated, the most advantageous for the germination of the seed or the growth of the plant.

* Two inches by the action of the crank, and other 2 inches by the lowering of the frame to which the crank is attached.

It has been customary to trample and roll, and by every means firm the land after wheat-sowing, to hinder the frost from throwing the young plants out. On this account, when my father stated his intention to a party of farmers who were walking over Whitfield Example farm, of sowing wheat on a field which had been subsoil-ploughed in the spring, and had borne an excellent crop of swedes, and which was then, after having been cultivated with Scoular's implement, in as loose a state as possible, they tried to dissuade him, and foretold that the young plants would, on the first frost, be thrown out. The plants certainly sustained some severe frosts, but the result showed the fears expressed to have been unfounded. The Norfolk farmers, I believe, are very careful, in ploughing for wheat, to break the furrow-slice as little as possible, and to firm the land as much as possible, before sowing their wheat. They find that this tends to hinder the frost from throwing out the plant. May not this throwing out by the frost, upon wet land at least, be explained in this way? The rain falls on such land, and sinks in till it comes to an impervious bottom, at no great depth, where the land has never been stirred by the plough or otherwise. It remains there, and, on freezing in winter, it of course forces open the land, and the plants are thrown out and killed. There are two ways of hindering this: one is to trample and roll the land, and make a hard surface, so that the rain, on falling, flows over the surface and is carried away by the open furrows. It thus does not sink in. This is the plan generally followed, but it often fails, as I believe the experience of many would testify. Would not the better plan be to drain the land and put in the subsoil-plough and work it with the scarifier? The rain, on falling, will certainly sink in, but it will sink far beyond the reach of the frost, and will be carried away by the drains, the plants at the same time deriving all the advantages of a free and open soil.

[To be continued.]

XI.—On the "*Tchornoï Zem*," or *Black Earth of the Central Regions of Russia*. By RODERICK IMPEY MURCHISON, F.R.S., President of the Geological Society.

[Since the accompanying sketch was read before the Geological Society of London, I have added to it the valuable analysis of the black earth by M. Payen, and have willingly acceded to the request of my friend Mr. Pusey to publish it in the volumes of the Agricultural Society.]

In previous communications respecting the geological structure of Russia in Europe, M. de Verneuil and myself gave a sketch of the superficial accumulations which are apparent in the northern governments of that empire. In conjunction with our associate, Count Keyserling, we shall revert to this subject, both with the view of adding to our former stock of knowledge that which has resulted from recent researches, and also to show in one connected memoir the relations of all the varied superficial detritus

of Russia. The object, in the mean time, of this short notice is to call attention to a superficial deposit which occurs at intervals over enormous tracts in central and eastern Russia, and which, from the uniformity of its colour and composition, is without parallel in Europe. Though Pallas and the older writers upon Russia have briefly noticed the occurrence of a black vegetable mould, they have neither described the extent of ground occupied by it, nor its composition; still less have they speculated upon its probable origin. The Baron A. Von Meyendorf, my companion in a part of my first journey, in a letter to M. Elie de Beaumont, has indeed spoken of this material as being one of the chief sources of the agricultural wealth of the empire.

Having recently, however, had the opportunity, in company with M. de Verneuil and Count A. Keyserling, of tracing the relations of this black earth over wider tracts than perhaps any modern observer, I have thrown together a few remarks which may serve to explain, 1st, the range and extent of the deposit, and its relations to the physical features of the land; 2ndly, its agricultural properties; 3rdly, its chemical composition; 4thly, the theory of its origin.

1. The black earth has its northernmost limit defined by a waving line which, passing from near Kief and Tchernigof, a little to the south of Lichwin, appears in the 54° of N. lat. in that tract, then advances in its course eastward to the 57° of N. lat. and occupies the left bank of the Volga west of Tcheboksar, between Nijny Novogorod and Kasan. In approaching the Ural chain, we saw no black earth to the north of Kasan, but we observed it plentifully on the Kama and around Ufa. Again, on the Asiatic or Siberian side of the Ural mountains we travelled through one large oasis of it near Kamensk, south of the Issetz river in latitude 56° N., and through another, between Miask and Sviask. Of its limits in the great Siberian plains we cannot speak from personal observation, but we were given to understand that it spreads over a considerable area in the eastern and central parts of that region. Nor can we exactly define its southern limits in these eastern longitudes, for although we met with it occasionally in the gorges of the chain and in the Baschkir country on both flanks of the southern Ural, and also in the steppes of the Kirghis, we cannot pretend to say if it extends far to the south of Orenburg. We know, however, that it is not to be seen in the flat southern steppes between that place and the mouth of the Volga which were traversed by us; for there the surface is strewn with fine submarine detritus containing numerous shells of the same species as those which now inhabit the adjacent Caspian. Nor have we seen any black earth to the south of Tzaritzin on the Volga, or on the steppes of the Kal-

mucks between that place and the mouth of the Don; nor indeed anywhere except in very limited patches along the sea of Azof, or in other words on the southern face of the axis of elevation between the Dnieper and the Don, which is a prolongation of the Carpathian chain, and constitutes what is commonly called the granitic Steppe. It occurs, however, in great thickness on the slopes and plateaux on the northern side of that axis, where, as it really surmounts the carboniferous limestone with many seams of coal, a geologist who had not observed it in other places might at first sight be led to suppose that the black matter was due to the decomposition of the subjacent carbonaceous strata.* It lies, however, upon rocks of all ages, and the great masses are included in the central region thus roughly defined. Geologically considered, therefore, the Tchornoï Zem occupies the centre of a great trough as large as an European empire, having the detritus of the crystalline and older rocks for its northern and the low granitic steppes for its southern limits.

It is found at all levels, sometimes on plateaux, as on the right bank of the Volga, high above the adjacent plains, in various parallels, from $56\frac{1}{2}^{\circ}$ N. lat. to the high grounds extending to Saratof, and at heights of not less than 400 feet above the valleys; in other places on slopes and undulations, and often in broad valleys, where the rivers, having cut through the deposit, expose its thickness on their banks. In the country where the southern limits of the northern drift are traceable, it is interesting to observe that its materials, reduced to small size, are overlapped by the black earth.

I may here remark, that on the plateaux and their sides, the black earth, like all the other alluvia of Russia, is constantly cut into by the ravines, called "avrachs" or "baltas" by the Russians, and which invariably show it to be the uppermost deposit. These ravines have been mentioned in a former communication; but the attention of English geologists cannot be too frequently called to them, as the rapidity with which they are laid open after the ground has once begun to yawn, is something quite surprising to those who have been accustomed only to survey the trodden tracts of Europe and other parts of the world.

Central Russia, indeed, may be described as consisting, to a very great extent, of a series of undulations, composed of *incoherent* materials, or, in other words, as a country so devoid of a visible skeleton or framework, that the vast increment of clay, sand, or mud, which occupies her surface, is easily denuded when

* These coal-fields have since been described in the account of the general structure of central and southern Russia, communicated by myself and companions to the Geological Society of London.

any adequate cause is brought into play. The opening or fissuring of these masses, then, is due, in the first place, to an extreme climate, which subjects the surface to intense and long droughts, alternating with heavy debacles, arising from the melting of thick coverings of snow and ice. During the hot and parching summers the argillaceous grounds necessarily split into rents, and wherever these occur upon slopes, the thaw of the succeeding spring liberating vast bodies of snow and water, the smallest crack of the previous year is enlarged into a gulley, which, widening as it descends, becomes in a few seasons a broad and deep ravine, through which the masses of melted snow, mud, sand, and clay are transported into the adjacent river. It is the conjunction, therefore, of the very incoherent nature of the upper deposits of Russia with the extremes of her climate which explains the formation of the innumerable ravines that fissure her surface. It would indeed be a curious problem to ascertain to what extent these ravines encroach annually upon the best arable and pasture grounds of the empire, and in what progression this waste takes place; as proved by the rapidly increasing deltas at the mouths of the Volga, Don, &c., and by the very perceptible silting up of the Sea of Azof. In no instance have I seen any means adopted to check this continual wear and tear, by which millions of tons of the richest soils are annually destroyed, and transported away by the great rivers. In the mean time, the geologist has to thank these "avrachs" for most of his best sections, for it is generally near their mouths, where the denudation has been deepest, that the parent-rock or true subsoil is laid bare. I may here also state, that it is owing to the ravined nature of the sides of the hills, and the wide mouths of these gullies, that the great roads of Russia pass almost invariably over the highest table-lands, where the "avrachs" are, comparatively speaking, absent. Instead of travelling along the banks of the great water-courses, as we might think would be the case by an inspection of a physical map, it has been found impossible to maintain roads along these lower levels,—first, from their being inundated during certain seasons; and, secondly, by the innumerable mouths of the ravines, which defy all the efforts of bridge-makers, and are for ever changing their courses and dimensions.

Returning, however, from this allusion to a phenomenon which affects all the incoherent deposits of Russia, to our special subject, it must be clearly understood, that the black soil of which we are treating does not, by any means, occupy all the vast country in question. It occurs, indeed, in areas sometimes consisting of several large parishes, and is invariably the superior deposit, covering all other accumulations of clay, sand, &c. In thickness it varies from a few feet to 15 or 20 feet. In travelling over

these black tracts in the dry summer of last year, my companions and myself were often, during a whole day, more or less surrounded by a cloud of black dust arising from the dried up "Tchornoï Zem," which, even in rich grass countries, like those east of Odoyef, is of so subtle a nature as to rise up through the sod, under the stamp of the horse's feet, and form so dense a cloud, that on arriving at our station we were often amused at our chimney-sweep appearance.*

2. The "Tchornoï Zem" is unquestionably the finest soil in Russia, whether for the production of wheat or grass. It is so fertile as arable land, that the farmers never apply manure; and, after taking many crops in succession, leave it fallow for a year or two, and then resume their scouring treatment. The natural productiveness of this soil has doubtless tended to confirm the prejudices of the peasants of Central Russia against the use of manure, enormous piles of which, the accumulation of ages, are seen behind most villages and towns, forming, between the houses and the river below them, hillocks of considerable magnitude, the export of which might really prove a very beneficial trade to those countries more advanced in agriculture, and whose poorer soils are worthless without repeated dressings of manure. In the mean time, however, it is right to state that well-educated Russian proprietors of such lands in Central Russia are now labouring hard to overcome the ignorance of their peasants, and have in some instances succeeded in inducing them to manure their fields; whilst in the northern governments, where the soil and climate are more adverse to the cultivator, improved agricultural habits are becoming prevalent, and in all the military and German colonies manure is regularly harrowed in, the culture being occasionally as clean as in some parts of Western Europe.

In the central southern regions I may particularly cite M. Davidof, an extensive proprietor of black earth in the rich tract between Stavropol and Sysran, as one of the most spirited modern agriculturists. Educated in Scotland, where he acquired

* Although it has been said that this black earth is unlike any superficial deposit in Europe, it is probable that the fine black earth of Hungary is merely a western limb of the great Russian accumulation. The "Tchornoï Zem" is indeed somewhat analogous in colour, uniformity of deposit, and fertilizing properties, to the "Régur" or cotton soil of the central (Deccan) and southern (Trichinopoly, &c.) districts of Hindostan. In a memoir communicated to the Royal Society, in 1837, by Lieut. Newbold, of the Madras Army, that officer describes this Indian humus as being spread out in patches over wide tracts, and at all levels, and it is supposed by him to have been formed under water. In aspect, however, as well as in composition, the "Régur" differs from the "Tchornoï Zem" in not being so black, in containing much coarser grains of sand, and also calcareous (tufaceous) concretions, which are attributed by Mr. Newbold to springs rising from the subjacent rocks.

a taste for good farming, he is endeavouring, with the aid of his very intelligent agent, M. Brummer, and by the example of model farms, to lead the people to use manure and eat potatoes, a root generally abhorred by the Russian peasant. Turnips or other green rotation crops being also unknown in the interior of Russia, I have little doubt that, with an improved system like that proposed and put in practice by M. Davidof, the agricultural products of Russia might be doubled.

It is not in my power to give an exact return of the crop yielded by the black earth, nor can I refer my readers to Schnitzler's Statistics of Russia, without cautioning them against what I presume to be an error, when that author states, that in good seasons this black ground, in the government of Tambof, returns from 10 to 15 for 1, and in other years from 7 to 10 for 1.* With a knowledge of the *treatment* which this soil undergoes, such estimates must be overcharged, if viewed as average returns. More recently, indeed, the Baron A. von Meyendorf has prepared an useful statistical map, not yet published, in which the whole of Russia in Europe is divided into three regions—of forest, corn, and steppe. He also states that the agricultural region affords 20,000,000 of hectares of wheat; but I may observe, that the amount of this quantity which proceeds from the black earth cannot be known until its limits are defined. Nor would it have given a fair idea of the productiveness of this soil to have simply noted down the returns at this or that spot, where the plough had been long at work, and no manure used. The true test would be to show the amount of produce when the black earth is first changed from a state of steppe or grass to an arable condition. Eager as the Russian cultivator is to convert such lands, there are still very wide tracts of Southern and Eastern Russia, and on the flanks of the South Ural, where no plough has yet broken in upon this fine virgin soil, and where it still is loaded with the richest crops of grass.

3. Chemical composition. On fracturing a hardened lump

* The mode of computing the fertility of a soil by the return from a given quantity of seed, which is commonly used by foreign writers, is very fallacious, as it depends, in a great measure, on the quantity of seed sown on a given space. If a sack of wheat be sown broadcast on an acre of land, and the return be 5 quarters, this will be only 10 for 1; but if 5 pecks be dibbled, and 5 quarters reaped, which is not uncommon, the return is no less than 32 for 1: yet the fertility of the soil is not in that proportion. In the rich black earth a smaller quantity of seed is required; and, supposing 3 bushels sown per acre, an increase of 15 for 1 would only give 45 bushels—no very extraordinary crop for such land, in a climate peculiarly suited to the growth of wheat; and 10 for 1 would only be 30 bushels per acre—no very great average. There may, therefore, be no error in the statement of the return of the black soil of Tambof.—W. L. RHAM.

which I extracted six months ago from beneath 10 to 12 feet of subjacent similar earth, all jet black when moist, and which I had kneaded together to bring away, it offered in its dry state a slightly ferruginous brown tint; and I further perceived that besides the black matrix, grains of lighter-coloured sand were interspersed. Having submitted a portion of this mass to Mr. R. Phillips, the Chemist of the Museum of Economic Geology, he has obligingly furnished me with this analysis:—

Silica	.	.	.	.	69.8
Alumina	.	.	.	.	13.5
Lime	.	.	.	.	1.6
Oxide of iron	.	.	.	.	7
Vegetable matter	.	.	.	.	6.4
Traces of humic acid, sulphuric acid, chlorine, &c.	.	.	.	.	1.7

100

Dr. Daubeny, who has also interested himself in the examination of this black earth, and has detected about the same proportion of organic matter as that noticed by Mr. Phillips, thus expresses himself:—"The possession of a deep soil, easily penetrated by the roots of plants, and containing so large a per centage of mild humus, would alone impart great fertility."

The celebrated French agricultural chemist, M. Payen, who analyzed a portion of this black earth at the request of M. de Verneuil, says:—

"The composition of this earth is remarkable for the proportion of azotised matter which it contains, and the volume of the azote. The connection between this earth and the organic substance, when the latter is so rich in azote, appears to me to be essentially one of the surest indications of the fertility of soil, other conditions of chemical properties and mineral composition being favourable. In this respect, and according to my compared analyses, the earth in question approaches very near to two of the most fertile soils of France, that of the Limagne d'Auvergne (valley of the Upper Loire) and that of the neighbourhood of St. Denis, near Paris, notably in the farms of Marville and Stains. I have great pleasure in authorising Mr. Murchison to publish this analysis and the opinion I here express, and shall be much honoured if these details find a place in the Memoir of the President of the Geological Society of London."

ANALYSIS OF THE BLACK EARTH BY M. PAYEN.

100 parts of earth	{	6.95 Combustible organic matter 93.05 Incombustible matter =	{	Soluble in boiling hydro- chloric acid	}	13.755	{	Alumine	.	.	5.04
								Oxide of iron	.	.	5.62
								Lime	.	.	0.82
								Magnesia	.	.	0.98
								Alkaline	.	.	1.21
								Chlorides	.	.	

K 2

or according to the quantities used in the analysis,	Insoluble in boil- ing hydrochloric acid	} 79.30	}	Silica . . .	71.56
				Alumina . .	6.36
	Earth.	Org. matter.	Incombustible.	Lime (traces of)	
				Magnesia . .	0.24
	1.724	= 0.119 +	1.605	} 0.237 soluble. 1.368 insoluble.	

After detailing the minute proportions of these soluble and insoluble contents, M. Payen adds, that the analysis of the combustible organic matter indicated the presence in 100 parts of the original earth, of

Water 4.81
Azote 2.45

7.26

4.140 grammes of the earth yielding 9.498 cubic centimetres of azotic gas.*

In order to avoid error, not pretending myself to be acquainted with the method of analysis employed by M. Payen, I here refer my readers to the original document.†

* If we only consider the chemical elements of which this black earth, which is stated to be so fertile, is composed, the analysis does not afford us much information, without a knowledge of its mechanical texture. The same elementary substances may be so variously combined as to produce very different soils in respect to fertility. Thus, if 70 per cent. of silica were in the form of small crystals, such as we find in sea-sand, and the 13 per cent. of alumina combined with the 7 per cent. of iron and the sulphuric acid were mechanically mixed with the sand, the result would be a soil not much superior to that of Bagshot Heath; and although the 6 or 7 per cent. of organic matter, especially with a considerable portion of animal matter, would give it some fertility, it would never be fit for the growth of wheat, from a want of firmness. But if the alumina is combined with the silica, so as to form clay, and a portion of the silica only is in the form of fine sand, making with the clay a loamy soil, and the oxide of iron be a peroxide not hurtful to vegetation, then the organic matter intimately mixed with this soil will form the richest wheat-loam. This confirms an opinion I have ventured to express elsewhere—that, when the silica is in a very high state of division, and intimately blended with the alumina, it can no longer be considered as sand; nor has it the porous quality by which sand is soon deprived of its moisture, and the organic matter is exhausted in it. This shows the necessity of a mechanical examination of a soil, which is so easily effected by sifting and washing alone, conjointly with an accurate chemical analysis, before we can form a correct opinion of the real fertility of a soil.—W. L. RHAM.

† Analyse de la Terre Noire de Russie, sur un échantillon transmis par M. Gourieff.
Analyse.

100 terre =	{	6.95 mat. organique combustible.	{	Alumine . =	5.04
				Ox. de fer . =	5.62
	{	93.05 cendres .	{	Chaux . =	0.82
				Magnésie . =	0.98
	{	Solubles dans l'ac. chlorhyd. bouillant = 13.79	{	Chls. alcals. =	1.21
				Silice . . =	71.56
	{	Insolubles dans l'ac. chlorhyd. bouillant = 79.30	{	Alumine . =	6.36
				Chaux (traces). =	0.24
	{		{	Magnésie . =	0.24

On d'après les quantités employées pour l'analyse 1.724 } 0.237 soluble.
terre = 0.119 mat. org. + 1.605 cendre = . . } 1.368 insoluble.

Whilst the analyses of these able chemists afford us nearly the same results as to the proportions of solid materials, we learn from M. Payen that the peculiar gaseous contents of the black earth may be the principal cause of its fertility. It would seem, indeed, that without a close attention to the proportion, not only of the soluble and insoluble constituents of soils, but also to their gaseous contents and their mechanical aggregation, it must be very difficult to estimate their fertilizing powers. Thus, in looking through the various British soils analyzed by Mr. R. Phillips, I find that a red, brick-coloured earth, already alluded to, from a property of Lord Calthorpe, (as dissimilar as possible in aspect and aggregation from the Tchornoi Zem of Russia, and differing also from it, I will venture to say, in produce,) has almost to minute quantities the same relative proportions of sand, clay, iron, and vegetable matter; though the Russian earth is black, permeable, and easily managed, and the English earth is red and tenacious. Again, we see by the comparisons of M. Payen with what very different soils in France he compares the Tchornoi Zem of Russia.

4. When we speculate on the probable origin of the Tchornoi Zem, the first impression might be that which the Baron A. von Meyendorf adopted in a letter to M. Elie de Beaumont, and which is indeed the prevalent opinion in Russia, viz. that it is the humus arising from decayed forests or vegetables. But I am obliged to dissent from this opinion, seeing the uniform nature of the soil and its distribution at all levels without reference to the existing drainage; and also from the fact, that in no part of the empire did my associates or myself ever perceive a trace of trees, roots, or vegetable fibre in the black mass. It is in vain to say

Mat. soluble dans ac. chlorhyd. bouillant =	0.237	Per 100.	Mat. insoluble ac. chlorhyd. bouillant =	1.368	Per 100.
Alumine	0.087	36.70	Silice	1.232	90.24
Ox. de fer. . . .	0.097	40.91	Alumine	0.110	8.03
Sulfte. chx. = 0.036	0.014	9.90	Chaux	traces.	
= chaux			Magnésie	0.008	0.90
Magnésie	0.017	7.17			
Chlorures alcal. . .	0.021	8.86			

DOSAGE DE L'AZOTE.

Données.

Mat. employée =	4.140
Pression =	76.94
Températ. =	19° c ^x
Vol. gag. obt. =	9 ^{cc} 9

Mis vide =	9.190	eau per cent.
Perte =	0.290	
		= 4.81

A incinérer =	1.724	cendre per cent.
Cendres (rouges) =	1.609	
		= 93.09

Résultats.

Mat. normale employée =	4.140
„ sèche =	3.940
„ organique pure =	0.279
Vol. récl. de l'azote =	9 ^{cc} 498
Poids =	6 ^{ire} 861
azote { Mat. normale =	1.66
pour { „ sèche =	1.74
1000 { „ pure =	24.99

that such vegetables may have been entirely decomposed; for in the deep denudations which expose 15 to 20 feet of this matter, surely some remains of the forests or bogs would be found in the lowest parts of the solid earth, just as we find roots and branches of oak, pine, birch, and hazel in our peat bogs.

But if, for these reasons, it be impossible to adopt the hypothesis of simple terrestrial origin, and that we consider it a subaqueous deposit, with what known accumulation shall we compare the black earth?

Having referred to some of the difficulties which are to be overcome before the practical farmer can avail himself of the lesson which is offered to him in the crucible of the chemist, I will (claiming the forbearance of agriculturists) say a few words on the geological relations of this Russian earth, and conclude with an attempt to explain the cause of its colour. With what known superficial deposit, then, are we to compare it? Is it to be placed in parallel with the equally finely levigated silt which the Germans call Löss, or with the upper diluvial mud which in Belgium, France, and Germany is said to bound the northern drift? Though this comparison is made by M. A. Erman, and has been alluded to by the eminent geologist M. E. de Beaumont, I do not conceive that it can be sustained. With the ordinary diluvial or drift clay the black earth has, indeed, nothing in common; for it does not contain a single transported pebble. Besides, it overlaps, and is never mixed with, that drift which occupies such large tracts of northern Russia. Again, the composition of the "Tchornoi Zem" is most distinct from the Löss of Germany, which light-coloured, sandy, calcareous mass is abundantly filled with terrestrial and lacustrine shells in perfect preservation, clearly indicating that it was accumulated on the sides of ancient, wide, lacustrine rivers, which were barred up so as to form lakes in the way described by Mr. Lyell, just before the present configuration of the land was completed. The fact, also, that the Löss has not yet been seen on high plateaux, but occupies the sides and bottoms of the great valleys in which rivers flow, is in itself sufficient to prove that, although it may have been accumulated at nearly the same epoch, it cannot be considered as the exact equivalent of the "Tchornoi Zem," which contains no terrestrial and fluviatile remains, and is found at all levels without any relation to the existing water-courses.

Debarred, by the absence of any portions of plants in its composition, from referring it to the decay of ancient forests, and unable to compare it with any known deposit, from the absence of all organic remains, let us see whether the very peculiar nature of the physical, geographical, and geological conditions of Russia may not help us to a solution of the problem.

Unlike all great regions hitherto examined, central Russia is void of rocks of igneous origin or intrusive character, and all her strata deviate from horizontality only by the slightest undulations. From this fact and from the incoherent texture of the rocks it is clear that her subsoil, which on account of its marine contents we know to have been formed *under the sea*, must have been raised and desiccated by very gradual and even movements. Judging from the evidences of geological succession also, and seeing that, without the aid of great fractures or dislocations in the crust of the earth, some of the older rocks of Russia, such as the mountain limestone, are covered conformably by the inferior oolite, whilst the lias and, to a great extent, the new red sandstone are wanting, we see in these facts the proofs that either the former bottom of the sea was raised above the waters and remained dry for long periods, or that, in this very tranquil region of the earth's surface, the absence of all widely-spreading powerful currents ceased, at intervals, to extend from the neighbouring seas and rivers. Pursuing this mode of reasoning from the more ancient phenomena to those which immediately preceded our own era, we are led by positive evidence to conclude that the whole surface of central Russia (however parts of it may have had formerly dividing barriers) was during that period again depressed beneath the level of the sea, in which the marine shells of the government of Archangel and the Southern Steppes were accumulated, and over which the sand, clay, pebbles, and blocks of the north, as we have before described, were deposited.

In all those parts where the strata show no signs of dislocation, the present physical features of the country, indeed, serve to explain the outline of the southern edge or extreme range of the northern drift; for where high plateaux, like those on the left bank of the Volga between Nijny Novogorod and Kasan, stand out with their cliffs to the north, there we trace a well-defined limit beyond which that drift has not proceeded; and where, on the contrary, longitudinal valleys, like that of the Okka, open to the south, there we perceive that northern blocks have advanced from 50 to 150 miles farther. In no part, however, of the great northern region occupied by the northern drift is there a trace of the "*Tchornoi Zem*," though yellow and white sands and stiff clays abound, the latter constantly charged with transported pebbles like our English drift or diluvium.

Extending then as far southwards as currents, icebergs, and other causes, to which I have formerly referred, would transport them, and a *submarine* outline would permit the materials to advance, it is very natural to suppose that, where the northern drift ceased to advance, the bottom of the then sea, far removed from any currents, or unagitated by any disturbing force, would

become covered with fine silt or mud, such as we know, from the soundings of hydrographers, is often found beneath mediterranean waters, far removed from the action of currents.

The absence of any marine shells in this fine sediment is, it is true, a negative fact, which, if unaccompanied by some explanation, might indispose my readers to admit this hypothesis. We must, however, bear in mind that, after their emersion, the central parts of Russia, if but slowly and slightly elevated, may have long remained in an intermediate state of mire or slough with little egress for water; so that the remains of delicate testacea (if they existed) may have been entirely decomposed by the alternations of aqueous and atmospheric agency. But whether we adopt this view or not, we cannot, I repeat, look at the very great uniformity of its composition over such vast tracts, and its independence of existing drainage, without rejecting any theory which would account for the production of the "Tchornoi Zem" by subaërial causes only, and on these grounds we must, I think, account for its origin by aqueous deposit and the subsequent modifications which it underwent in passing into a terrestrial condition.

Lastly, I am borne out in this inference by the black colour of the soil; for whilst the eminent chemists above cited have ascertained that soils of very different external appearance are nearly identical in their analysis with the black earth of Russia, the remaining difference, or that of colour, may be due in the English and French examples to the vegetable matter being less decomposed than in the case of the "Tchornoi Zem," an argument I beg leave to adduce as an additional proof of the materials having been originally deposited under water.

XII.—*Lecture on the Application of Science to Agriculture. Delivered before the Members of the Royal Agricultural Society of England, on Thursday the 9th of December, 1841.* By CHARLES DAUBENY, M.D., F.R.S., Hon. Mem. of the R. E. Agricultural Society, Vice-President of the Geological Society, and Professor of Rural Economy in the University of Oxford.

IN acceding to the request made to me a few days ago on the part of the Council of the Royal Agricultural Society through their President, and attempting, in conformity with their wishes, to deliver before the farmers now assembled in the metropolis a lecture on some subject connected with the class of pursuits

which this Institution is designed to foster, it may doubtless appear to many of you that I have undertaken a task, and am occupying a position, which neither my previous studies nor my present occupations justify me in assuming. For one indeed like myself, whose personal experience on matters of rural economy is nearly limited to the narrow precincts of a garden, to attempt instructing such an Assembly as the present on the conduct of operations with which many of those who constitute it have been familiar from their earliest years, and which in every case must form the subject of their daily thoughts and occupations, I should indeed regard as the extreme of presumption, were it not for the reflection, that the Society before which I now appear is expressly instituted for the purpose of connecting science with practice, and of summoning to the support of the agriculture of this country all the supplementary aid which either geology, botany, or chemistry may be capable of affording it.

As, therefore, on the former evening, you listened with interest to a Professor of a sister University, when discoursing on subjects respecting which his own exact botanical knowledge, and his general acquaintance with the proper methods of experimenting, enabled him, though not a practical farmer, to speak with something like authority—so, on the present, it shall be my humble endeavour to bring under your consideration those departments of agricultural inquiry, upon which the science of chemistry either has thrown, or seems likely to throw important light.

Proceeding, however, in that cautious spirit which ought to be our guide in matters of such great practical moment, a spirit too which is expressly inculcated by the Society whose members I now address, it is not my intention to prescribe to you any particular modes of culture, even in cases where I may conceive that the present system runs counter to approved principles of science—but I would rather wish to suggest doubts, to pave the way to new lines of investigation, and to point out the manner in which those experiments which you are undertaking ought to be prosecuted, so as to produce results most useful to the public and to yourselves.

Few, indeed, who recollect the opposite systems of farming pursued in various parts of England, often without any corresponding variations in soil and climate to account for them, who consider the unequal amount of produce obtained from land of apparently similar quality in different situations, and are reminded of the superiority in certain points of husbandry which must be conceded to nations inferior to our own in the scale of civilisation, will doubt that the agriculture of this country is far indeed removed from perfection; and as no fault can be found

with the industry, the diligent attention, the energy which pervades the agricultural, no less than every other portion of the British people, the most promising direction in which we may hope to attain improvement is by arriving at more enlightened views with respect to the principles of husbandry, a more thorough understanding, of the nature of the soil we operate upon, and of the agents by which its condition is to be ameliorated.

It must be admitted, indeed, that there was at no period of our history a greater disposition for making trial of new methods of culture; and, moreover, that the experiments most popular at the present time are precisely those which have reference to the action of chemical agents upon the soil. But, judging from those cases which have fallen under my own personal observation, I should be led to apprehend, that the unscientific manner in which the investigations are oftentimes conducted, and the absence of any leading principle in the selection of these fertilising agents, or in their relative order of succession, have hitherto detracted much from the value of the results obtained.

I may be permitted perhaps to illustrate my meaning by reference to another practical science, bearing some points of analogy to that which we are now considering. Let us suppose a physician, without being directed by any insight into the structure and functions of the human frame, or into the chemical nature of the drugs employed in medicine, to prescribe to his patients indiscriminately the various articles of the 'Materia Medica' in succession, either singly or intermixed, noting down the results, and communicating from time to time to the world the cases in which he had fancied himself successful. Such a person, supposing his practice sufficiently extensive to enable him to ring all the changes of which the numerous medicinal agents at his command admitted, might no doubt in time discover some valuable remedies, provided only he were able to convey to others a correct idea of the nature of the ailments, and of the kind of constitutions, in which each particular mode of treatment had proved successful. But supposing that the nomenclature of disease at the period in which he lived was loose and uncertain, supposing that what was called fever in one place was known by some different appellation in another, I fear it would be difficult for him to render the information he had acquired available, except perhaps to those within the narrow limits of his own neighbourhood. His discoveries, therefore, must either die with himself, or, if adopted by others, must be expected to lead to many disappointments, from the mistakes that would occur as to the kinds of disorder they had been found calculated to remove.

Now the present condition of agriculture does, I fear, in both these respects, resemble that which I have just been delineating :

there is no lack, indeed, of diligent and active prescribers, or of new recipes for improving the constitution and remedying the defects of the soil: but inasmuch as they have been tried, like the nostrums of the empiric, without any directing principle, we know not how to adapt them to the altered circumstances of the land; whilst, owing to the want of an exact nomenclature, calculated to serve as an universal language, wherewith to express the character of our soils, we are even disappointed in applying them where the circumstances are conceived to be the same.

Professor Henslow has already, in his lecture of yesterday, remarked the vague sense in which many terms are used by husbandmen, no less than the difference in their acceptation amongst this class of persons from that which they are commonly understood to imply; and it must be confessed that what he has pointed out as a defect in agricultural language in general, is applicable to the nomenclature of soils more particularly.

Thus any loose clay is called marl in some parts of England, and loam in others; whilst the latter term is interpreted by one person to mean a fat earth, and by another is defined to be a mixture of clay, calcareous earth, and sand, without the proportions being stated.

“On referring to books on husbandry” (says Sir G. Sinclair), “we are directed to a hazel-loam, a brown-loam, a clayey-loam, or to a humid sandy soil, garden mould, &c.; but, owing to the perplexity arising out of the want of proper definitions, we find it utterly impracticable to determine what kind of soil is meant; so that, of fifty different kinds I have myself examined in various parts of the kingdom, those under the same name appeared to differ greatly in their respective qualities.”

I will therefore propose to the adoption of agriculturists, as a preliminary step, a system of classifying soils, founded expressly and entirely upon the relative proportion of their prevailing ingredients—namely, that of the siliceous, the argillaceous, and calcareous earth present in them.

In the arrangement now offered for your consideration,* we will begin with those soils which contain little or no calcareous matter—at the outside, not so much as 5 per cent. of the whole mass.

These, supposing them to possess 50 per cent. of clay, are placed under the head of argillaceous soils, and are distinguished into two orders, the first wholly destitute of lime, the second containing less than 5 per cent. of that earth. Each of these orders are then subdivided into three species, distinguished as rich, poor, and intermediate, according to the proportion of humus or

* See Table I.

vegetable mould present in them. If the amount of this ingredient be not more than $\frac{1}{2}$ per cent. the soils are called poor, as the fertility of a soil is in all cases greatly influenced by the proportion of this ingredient; if it varies from 0.5 to 1.5 per cent., it is called intermediate; if from 1.5 to 5.0 per cent., it is distinguished as rich.

The second class of soils comprehends those which contain from 30 to 50 per cent. of clay, and is denominated loamy. These likewise are divided into two orders, the one with, the other without lime; and again into three species, according to the proportion of vegetable mould present in them.

The third class embraces those soils which contain not more than 30 nor less than 20 per cent. of clay. They are called sandy loams, and are subdivided into orders and species, on the same principle as before.

In the next, or fourth class, under the denomination of loamy lands, are ranged those soils which contain from 10 to 20 per cent. of clay: the remainder, with the exception of the small per centage of limestone and humus they may contain, consisting of sand.

The fifth class, designated as sandy, includes all those soils in which the proportion of clay does not exceed 10 per cent.; and here again the same subdivisions are adopted.

Hitherto, the amount of calcareous matter present is not supposed to exceed 5 per cent.; but in the next class, that of marly soils, the above ingredient ranges in a proportion varying from 5 to 20 per cent. of the whole.

Marly soils are to be distinguished into five orders, of which the first, called argillaceous, contains about 50 per cent. of clay; the second, loamy, from 30 to 50; the third, sandy-loamy, from 20 to 30; the fourth, loamy-sandy, from 10 to 20; and the fifth is distinguished by the larger proportion of *humus*, which exceeds in quantity 5 per cent. of the whole, and is therefore denoted as *humous marl*; which last is divided into three species—viz., argillaceous, which contains above 50 per cent. of clay; loamy, which contains from 30 to 50 per cent.; and sandy, possessing from 20 to 30 per cent. of the same ingredient.

We next arrive at that class of soils which contains more than 20 per cent. of carbonate of lime, and which is therefore distinguished as calcareous. These are subdivided according to the proportion of clay they may contain: when this earth exists in the proportion of more than 50 per cent., they are to be called argillaceous; when it is from 30 to 50, loamy; when from 20 to 30, they are said to belong to the sandy loams of the calcareous class; when from 10 to 20, to the loamy sands; and when either destitute of clay altogether, or containing at most only 10 per cent. of it, they are called sandy.

Lastly, a calcareous soil which contains more than 5 per cent. of vegetable mould belongs to the sixth order, that of humous calcareous soils, of which there are three species—namely, the argillaceous, the loamy, and the sandy, characterised, as before, by the larger or smaller proportion of clay present in them.

The last class, that of humous soils, is distinguished, in the first place, into three orders. The first consists of soluble mild humus—that is, of that description of vegetable mould which is in a fit condition to nourish the plants which grow in it; the second, of acid humus, namely, containing a free acid, which by its presence is highly destructive to most kinds of vegetation. A third order consists of fibrous vegetable matter, such as peat, which, though not acid, is yet in a condition little fitted for imparting nourishment to plants. These orders are again subdivided into argillaceous, loamy, and sandy, according to the proportion of clay present in them; and lastly distinguished into two species, the one containing, the other destitute of calcareous matter.

Such is the classification which has been proposed by a German writer,* and which appears to me to have the merit of embracing almost every variety of chemical composition found in nature amongst soils; nor shall I make any apology for entering into this detailed explanation of it, as I conceive that, independently of its use in suggesting to us in what ingredients a given soil may be deficient, the advantage of being provided with a method of accurately defining the quality of any piece of land which has been made the subject of your experiments cannot but be appreciated by every practical farmer.

But now the question occurs—in what manner is the requisite information to be obtained? To a person altogether ignorant of chemistry the only method that presents itself is to depend upon the science of others, and to obtain an analysis of the soil from some competent authority; but as this, if adopted frequently, would prove both expensive and troublesome, it were very desirable if that limited amount of chemical knowledge could be diffused throughout the agricultural community which might enable each individual to determine for himself, in a rude way, the chemical constitution of the soils he cultivates. Certain easy directions for this purpose are given by the Rev. Mr. Rham, in the first Number of the Journal published by this Society; and I am persuaded that by following his instructions every farmer would be enabled, if possessed of a slight elementary knowledge of chemistry, to ascertain, after a little practice, the con-

* Schübler, in his work entitled "*Grundsätze der Agricultur-Chemie.*" Leipsic, 1838.

stituents of his land, so far as to determine its proper place in our system of arrangement.

Let me, however, remind you that such a rude analysis as I recommend tells you nothing respecting the presence or absence of many ingredients, which exist indeed in minute quantities in the soil, but which nevertheless occasion the most decided differences in its qualities as affecting vegetation. Such are the alkalis and the phosphoric acid, both of which necessarily escape detection whenever we examine such small quantities of the soil as usually are submitted to analysis. It is therefore no reflection upon Sir H. Davy, in the last age, or on any chemist of the present, if, under such circumstances, he is silent as to the presence of these ingredients in the samples which he had undertaken to analyse.* If, therefore, information be sought on these points, larger portions of the soil must be sent, and a greater amount of chemical skill will be called into requisition; but where the object is merely to determine the sort of soil which exists on a given property, then a small quantity only need be examined, and a degree of science, such as would be easily attainable by most farmers, will suffice.

Furnished, then, with this species of universal language, the agriculturist would be enabled to speak intelligibly, whenever he attempted to convey to others the results of his own experiments on the culture of land of a particular quality: he would then stand in the position occupied by a physician of a remote

* Thus Sir C. Lemon last autumn expressed to me his surprise that a sample of the soil taken from the Serpentine of the Lizard was pronounced by Mr. R. Phillips, to whom it had been sent for examination, to be totally destitute of magnesia. I told him that I could myself state that no quantity of that earth considerable enough to be detected in a sample consisting of only a few hundred grains was present in it, having some time back executed a rough analysis of this soil. It would have been rash, however, to have concluded from this that magnesia was *entirely absent*, for Mr. E. Solby has since informed me, that by operating on a much larger amount he has succeeded, not only in detecting the existence of the earth in question, but even of estimating the proportion it bears to the other ingredients. It has been remarked in the text, that phosphate of lime is another constituent of soils often overlooked, owing to the small quantity usually submitted to analysis. I may add, that several years ago I detected its presence in a great many specimens of secondary limestones in which Dr. Buckland had suspected the existence of *coprolitic* matter (one no doubt, but by no means the only source, from which it is derived). Within the last month I have been favoured by a letter from Mr. Schweitzer, the intelligent Director of the German Spa at Brighton, in which he states that he has discovered it in the proportion of one-thousandth part in the chalk of Brighton, and I have since found the phosphate in a somewhat larger quantity in the same formation, from the neighbourhood of Sudbury in Suffolk.

age, living at a period indeed at which the treatment of diseases was empirical, but at least possessing the means of conveying to others, by the aid of a precise system of nosology, a knowledge of the nature of the disorder for which a certain class of remedies had been found beneficial.

But the adoption of a precise nomenclature, though an important preliminary step, carries us after all but a small way towards that goal which the agriculturist should aim at attaining; and he who is content with knowing what manures will suit his land, without troubling himself to ascertain the principle on which they act, is as far removed from a system of perfect husbandry, as the empiric of a former age is from the more enlightened practice of the present day. Why, for example, a method of culture, which has succeeded to admiration on one kind of land, appears inapplicable to another; why a manure, which has produced great crops the first year, seems to lose its effect on the next; or why the fertilising influence which it exerted when applied originally should be succeeded by the opposite effect at a later period; why a difference of season should cause an entire change in its effects upon the same land: these, and many other problems of the same description, we can only be said to be on the way to solve, when we have first settled amongst ourselves the principle upon which the substances applied to our land operate in improving it.

At present the agricultural world seems divided on this point between two theories, both of them probably applicable to certain cases, but nevertheless carefully to be distinguished as leading to the greatest discrepancies in practice. The first of these considers manure as serving for food to plants: the latter regards them in some sense as stimulants to their vegetation.

Here, however, as in the former instance, much confusion has arisen, in consequence of the term *manure* being applied to designate two classes of agents essentially distinct. Thus some of the substances alluded to, such as quicklime, or its carbonate, act by improving the mechanical or chemical qualities of the soil and humus to which they are applied; and to this operation the French term amendment of the soil would seem to be appropriate. Other manures, on the contrary, such as the dung of animals, exert a more direct influence upon the plants themselves; and it is to these latter alone that either of the two theories alluded to can be considered applicable.

Thus whilst the former class of manures communicates to the soil those qualities upon which vigorous and active vegetation depends, the other may be supposed to supply the means for carrying it on; both of them conditions equally essential to the growth of plants, though each one perfectly distinct from the

other—just as the nourishment of an animal depends both upon a healthy state of his organs of digestion and upon a due supply of nutritious aliment.

There is, however, a third description of manures every day coming more and more into vogue, which are by some considered to supply food, and by others regarded as acting in the capacity of stimulants to plants.

To the latter class belong those various saline and earthy compounds, which a more extended acquaintance with chemistry, and an increased communication with foreign countries, have brought within the reach of the farmer: such, for example, as the nitrates of soda and of potass—the bone-earth, so extensively employed upon our turnip-fields—the gypsum, so useful on clover and grass land—and numerous other mineral substances, which will immediately occur to you.

To ascertain in what manner these latter kinds of manure operate in fertilizing the soil is not, as some might suppose, a mere object of curiosity or of speculative interest, since its decision will afford us the means of determining the proper proportion in which to apply them, the kind of soils which will be most benefited by their addition, and many other points of an equally practical character.

Whether these substances ever operate in any other manner, as, for example, as stimulants, may be afterwards discussed; but that some of them at least are serviceable, by providing those constituents which the soil only contains, if at all, in limited quantities, cannot, I think, be disputed.

With regard to bone-earth, which is now so extensively applied to the lands of this country, there can be no doubt that phosphate of lime, which constitutes its predominant ingredient, is secreted by the organs of a plant, and supplies the place of that which had been drawn from the soil by preceding crops. Its peculiar adaptation for turnips, which contain a larger per centage of phosphoric acid than any other of the ordinary crops of this country; its usefulness on dairy-farms, where a great quantity of phosphate of lime is continually drawn from the soil in the form of butter and cheese sold off the estate; and its serving to a certain extent as a substitute for farm-yard manure (the solid part of which consists in a great degree of this same substance), are circumstances all lending support to such an opinion. Now, with the view of taking advantage in our practice, as far as possible, of a theory which seems so plausible, as well as of testing its truth still further by the results of our experience, I conceive it would be a very useful exercise, if each agriculturist, besides entering in a book the amount per acre of the crops obtained, and of the different kinds of manure applied, were also to calculate the weight

of those solid ingredients contained in his crops, of which the soil possesses only a limited quantity; as likewise the weight of the same which was present in the manure that had been added to them.

But as an actual analysis of his crops, though by far the most accurate method of attaining such knowledge, would involve a degree of labour and science which few agriculturists could afford, it seems desirable that tables should be drawn up of the ingredients existing in all our ordinary crops, compiled from the best authorities that can be obtained. A specimen of such a table, which I have myself constructed for this purpose, stands now in the room under the title of "Agricultural Constants;"* and on inspecting it you will immediately understand that it would be easy for the farmer to establish a system of *scientific bookkeeping*, by entering on the debtor side the materials that had been abstracted from the soil by his crops, and on the creditor side that restored to it by his manure: thus enabling him to ascertain whether his plan of farming has a tendency to enrich or to impoverish his land. From this table it will appear that if an average crop of—

		Phosphoric Acid.	
		lbs. oz.	
Wheat be reckoned at 30 bushels, weighing 1800 lbs., it			
will have abstracted from the soil	.	.	7 3
Barley, 36 bushels = 1,900 lbs.	.	.	4 0
Oats, 30 do. 1,200	.	.	0 13
Potatoes, 6 tons 13,000	.	.	5 3
Turnips, 30 do. 33,000	.	.	24 0
Clover, { 1st cutting, $1\frac{1}{2}$ load } = $2\frac{1}{4}$ at 1 ton per load	.	.	6 3
{ 2nd do. $\frac{3}{4}$ do. }	.	.	
Beans, 24 bushels, 1,200 lbs.	.	.	3 8

Let us next illustrate this method of bookkeeping by reference to the Table now in the room, in which I have quoted the results given by Mr. Morton in his interesting work on soils, with respect to the system of husbandry pursued by him on Lord Ducie's example-farm at Tortworth. It will there be seen that, adopting his statements, there would have been abstracted per acre from the soil in six years—

* See Table II., on the Constituents of certain crops, a title which I have adopted in preference to that given in the text, as the proportions of the ingredients are by no means *constant*, varying, within certain limits not yet defined, according to circumstances.

				Phosphoric Acid.
				lbs. oz.
1st year, by mangel-wurzel, =	30 tons	.	.	11 1
2nd do. wheat, 4 qrs.	1900 lbs.	.	.	7 9
straw to do.	3000	.	.	1 12
3rd do. clover,	2600	.	.	3 10
4th do. oats, 7 qrs.	3000	.	.	2 0
straw to do.	3000	.	.	1 12
5th do. turnips, 25 tons	.	.	.	36 5
6th do. wheat, 4 qrs.	1900	.	.	7 9

Total of phosphoric acid . . . 71 10

As 214—442—71—147, about = 147 lbs. of phosph. lime.

Added to ditto per acre during the same period—

1st, The phosphate of lime present in the dung of
cattle fed on the farm . . . quantity unknown.

	lbs. oz.	
2ndly, Straw of the wheat	1 12	
,, oats	1 12	
	<hr/>	
	3 8	lbs. oz.
		3 8

3rdly, Fifteen bushels of bone-dust at 56 lbs. per
bushel, consisting of—

Animal matter	.	277 5			
Various salts, not phosphate	.	84 0			
Phosphate of lime	.	462 0	.	.	230 0
,, magnesia	.	16 5	.	.	9 0
		<hr/>			<hr/>
		839 10		Total	242 8

Now it follows from this calculation, that Mr. Morton had added to his land, in the course of six years, more by 171 lbs. of phosphoric acid than had been taken off from it by the crops, even without reckoning that present in the dung of the sheep and cattle, the quantity of which is not ascertained: so that it would appear, either that a much smaller amount of bone earth would have answered as well, or that some other purpose besides that of supplying the crop with phosphoric acid is fulfilled by it.

It must evidently be of the highest importance to determine which of these two be the true statement, since, if the former should turn out correct, then an unnecessary expenditure of an expensive material has been incurred; and if the latter be established, its recognition might lead us to discover some other material by which this secondary object could be more effectually attained.

Amongst many other suggestions that may occur to us from having such tables constantly before our eyes, there is one to which I shall advert, inasmuch as it bears relation to certain

points of theory recently introduced, and pregnant with some most important applications to practice.

Upon turning to the Table of Agricultural Constants you will perceive, that whilst an average crop of turnips, if estimated at 25 tons, contains 24 lbs. of phosphoric acid, one of wheat, consisting of 1800 lbs., will contain only 7 lbs. 3 ozs. of that ingredient; and yet that, on examining the per centage of nitrogen, its proportion in either case will appear to approach nearly to an equality: that present in the crop of wheat being about $4\frac{1}{4}$ lbs.; and in the crop of turnips, $5\frac{1}{2}$ lbs.

Now the interesting researches of Professor Liebig, with which I presume the agricultural world is by this time familiar, and upon which, moreover, I am unwilling here to dwell, as they have already formed the subject of one of my former lectures, reprinted in a late Number of this Society's Journal—these researches, I say, seem to have rendered it probable that nitrogen cannot be secreted by plants directly from the atmosphere.

I am aware, indeed, that the French chemist, Boussingault, was led to the opposite conclusion, from experiments made by him upon the Jerusalem Artichoke; but the nitrogen which this vegetable appeared to have drawn from the air may, I conceive, have been derived from the ammonia which rain-water always contains, and which vegetable mould holds in a condensed state within its pores.

If this be admitted, it will then follow, that nitrogen, in order to furnish food to plants, must always have been previously combined with some other element, by which that tendency to assume an elastic state, which would prevent its assimilation, may be controlled.

Hence the dependence of a productive wheat-crop upon an abundant supply of animal manure, which, by disengaging ammonia, affords it this necessary element in a fit condition to undergo absorption; and hence the superior efficacy of liquid manure over every other kind, as it disengages a larger amount of the volatile alkali.

By reference to the Table now standing in the room,* it will be

* The Table is extracted from one given by Hermbstoedt, in the 'Annalen der Landwirthschaft,' vol. xxii., Part I., and is as follows:—

100 parts of wheat, in soil manured with—

			Contained of	
			Gluten.	Starch.
Human urine (dried)	.	.	35.1	39.1
Bullock's blood (dried)	.	.	34.2	41.3
Human fæces (dried)	.	.	33.1	41.4
Sheep's dung	.	.	22.9	42.8
Pigeon's dung	.	.	12.2	63.2
Cow's dung	.	.	12.0	62.3
Vegetable humus	.	.	9.6	55.9
Same, but not manured	.	.	9.2	66.7

seen, that the proportion of gluten to starch, as well as the aggregate amount of the crop itself, is augmented by manuring the soil with those materials which are richest in ammonia, such, for instance, as blood, pigeons' dung, &c.

Now the practical inference I would deduce from this is, first, that it must be of the highest possible importance to preserve in tanks, or at least to detain, by the admixture of absorbent materials, the liquid manure which is so often allowed to run to waste on your dunghills; and, secondly, that it might be worth trying whether a better distribution of the manure at the disposal of the farmer might not be made, by adding the solid portion of his dung-heap, which is richest in the phosphates, to the turnip crop, and reserving the drainings, to be scattered, after the Belgian fashion, in water-carts, over the ground intended for his wheat.

May not this also serve to explain, why the nitrates of soda and of potass are in general found to be less serviceable to the turnip crop than to the cereal and other grasses?

Whatever other function these salts may discharge in agriculture, there is one at least which will probably not be denied to them, that, I mean, of furnishing an abundant supply of nitrogen to the crop. This arises from the decomposition of their nitric acid by the organs of the plant through the agency of light; and as it requires a greater expenditure of chemical force to resolve into its elements a compound so stable as nitric acid than to effect the same with ammonia, we may understand why the influence of these manures should be so capricious in climates like our own, where the solar intensity is often interrupted; and why Nature has provided that the products of animal decay should present themselves most commonly, in the form of nitric acid in hot countries, and in that of ammonia in cold ones.

Now it appears from some recent researches of M. Payen, in France,* that the rudiment of every vegetable tissue, the substance primarily produced in all instances during the development of the seed or bud, is a matter containing azote, and having some resemblance to the material which constitutes the muscular fibre of animals.

Access, therefore, to a certain amount of nitrogen is a necessary condition for incipient vegetation; and a supply of animal manure, or of some substitute for it, such as the nitric salts, must clearly be indispensable for the rapid development of every kind of plant. But it is equally manifest, that if a manure rich in nitrogen merely

* "In the cambium, preceding the formation of the vegetable, appears first a granular contractile substance, containing azote. It fills the cells, the membranes of which are composed of carbon, oxygen, and hydrogen only."—*Comptes Rendus*, 1839, vol. ii., p. 509.

be presented to a crop which, like the turnip, contains a large percentage of phosphoric acid, the growth of the latter may be checked, from its inability to obtain from the ground alone the requisite supply of this ingredient, whereas the grasses, which take up so much less of it, may find enough for their purpose in the soil, and therefore continue unarrested in their growth.

And this I take to afford the true explanation of the fact observed, that certain manures act more efficiently when first applied than they are found to do subsequently, a result which matter-of-fact persons are contented to express by the phrase that the ground is tired of a certain kind of dressing; and which those amongst them who indulge in theory account for by saying, that, like other stimulants, they lose their influence by repetition.

Now I am ready to admit that these manures, besides supplying the plant with nutriment, may exert an influence upon its development, of a description which it is, perhaps, necessary to denominate a stimulating one, until a more appropriate term shall have been proposed.

This has been clearly explained by Professor Johnston of Durham, in one of his recently published lectures,* where he shows, for example, by an appeal to actual experiment, that if two equal portions of the same grass or corn field in early spring be measured off, and one of them be top-dressed with nitrate of soda, or with saltpetre, the weight of nitrogen contained in the crop of hay or corn reaped from the latter will generally be found to exceed that contained in the crop from the former, by a quantity much greater than that which was present in the nitrate with which the field had been dressed. It seems to me, therefore, probable, that the fuller and more rapid development of the organs of the plant, which was occasioned by the exuberant supply of nitrogen derived from the manure, had enabled the living tissue to draw, from the atmosphere, and from the rain-water in contact with its roots, a larger amount of nitrogen than it would otherwise be capable of deriving from the same sources: just as an animal, which, during its infancy, has thriven on a liberal supply of wholesome and generous food, if it should afterwards be confined for a time to meagre diet, will extract more support from such materials than another would do, whose organs of digestion had been already enfeebled by a course of abstinence or depletion.

But in whatever sense we choose to interpret the so-called stimulating influence of certain manures, it is obviously pursuing a mistaken analogy to consider the falling off of their efficacy after repetition as a case at all parallel to that insensibility to

* See Johnston's Lectures on Agricultural Chemistry and Geology.

stimuli which animals acquire, from their continued use: for to imagine the soil, an inert mass, susceptible of such an influence, is obviously absurd; and inasmuch as every successive crop grown upon the land consists of an assemblage of new individuals, it seems no less so to imagine that a given stimulus can in any respect operate less energetically upon it, in consequence merely of its having been applied to the crop of the year antecedent.

In many of the cases in which, in the language of husbandmen, the soil is said to tire of a particular species of manure, the phenomenon may, I think, be readily explained, from the ground being already surcharged with the material which the latter was calculated to afford, as under such circumstances no benefit can be expected to accrue from a more liberal supply of it.

Thus, bone-dust, after producing great returns on its first application, seems frequently to lose all effect afterwards: in which case, however, it may be said that the ground remains benefited from the effect of the first year's dressing, and is only not further improved by the subsequent application of the same manure.

But, in other instances, it has been asserted, that the land, after appearing to reap great immediate benefit from a certain kind of fertiliser—as, for example, from the nitrates—is left by it afterwards in even a worse condition than it was in previously. Now this effect may, I think, become intelligible, if we only recollect, that the different ingredients which each plant contains must be secreted in relative proportions one to the other, so that an increased absorption of any one will produce a larger demand for all the rest.

Hence we may suppose, that the exuberant supply of nitrogen furnished by these salts had caused the organs of the plant to secrete so much larger an amount of the earthy phosphates, of the alkalis, &c., of which there is only a limited proportion present, that the crop of the succeeding year became stunted by reason of the soil being no longer able to afford to it, in adequate quantities, these essential elements of its constitution. And if this be the true account of the matter, the practical inference would seem to be that, instead of abandoning the use of the nitrates altogether, as the theory I have been combatting would suggest, it should be our endeavour to supply those other ingredients which are deficient, by the addition, at intermediate periods, of bone-earth or of wood-ashes, in proportions adequate to the demand for them, occasioned by the expected increase of crop.

Fortunately, we are provided, in the dung of animals, with a species of manure of which the land never can be said to tire; and for this simple reason, that it contains within itself not one alone, but all the ingredients which plants require for their nutrition,

and, what is perhaps of equal importance, existing too in that precise condition in which they are most readily taken in and assimilated.

Where this material is sufficiently cheap and abundant, other kinds of manure may for the most part be dispensed with; but as in certain stages of society the amount of animal life increases throughout a given region in a greater ratio than the fixation of gaseous matters which takes place through the instrumentality of vegetables can proceed, and as the existence of large cities tends to disturb the balance which nature seems to aim at establishing between the quantities of food produced and consumed, by attracting into their vortices a large proportion of the corn and cattle that has been reared in the country, it is well that we have at our command, in the various mineral manures which science has brought to light, the means of supplying the deficiency.

But, assuredly, the most effectual, as well as the most economical method of restoring the balance between the town and country would be to avail ourselves of that enormous accumulation of animal exuviae which the existence of a crowded city necessarily occasions, and to convert that which is now a *pabulum* of disease into a source of life and abundance.

As indeed the geologists of the present day cite as a proof of the ignorance or neglect of their predecessors, that the stone required for the fortifications at Gibraltar was brought out from England, when it might have been obtained upon the very spot; so I conceive our descendants will marvel at the inattention to chemical science evinced by the present generation of farmers, in exporting from distant regions, such as South America, substitutes, and those, perhaps, but imperfect ones, for that fertilizing material, of which the greater part is allowed to deposit itself unprofitably in the beds of our rivers.

Not that I would by any means be supposed to discourage, under present circumstances, the importation of fertilizing materials from abroad. Some of these, such as the Guano, lately introduced into this country from the islands of the Pacific, contain ammoniacal salts in a more concentrated form than any other known species of manure; whilst others, such as bone-earth, comprise within a given compass a larger amount of phosphoric acid—hence their portability may give them advantages, by securing greater economy of transport, in spite of the distance from whence they are brought: nor must we forget, that the measures for carrying off filth adopted in large cities are of a nature which would preclude us from obtaining it in sufficient quantity, in case that any great increase in the demand for it, as a manure, should hereafter be created.

It is only, therefore, to the neglect of this material in places where it can be obtained cheaply and abundantly, that my observations apply; but they may at least serve to suggest to us the advantages of making all the use of it we can, and of endeavouring to reduce what we have in excess to a condition in which it may be conveniently transported to a distance.

The means of preserving and rendering portable the night-soil and other impurities of a great metropolis, as well as the various expedients by which farm-yard manure may be applied to the best advantage, and its volatile parts either retained or slowly disengaged, as occasion may require, would alone afford us materials for another lecture—in the present I only allude to these topics as additional proofs of the advantages that would accrue, from having some amount of chemical knowledge diffused generally throughout the agricultural community.

But how is this important point to be secured? The present generation of farmers, living, as they often do, at a distance from the great emporiums of science, and being in all cases engrossed by the daily routine of practical avocations, can hardly find much time to devote to the acquisition of theoretical knowledge; and of them all perhaps that can be expected is, that they should arrive at a sense of its value, coupled with a desire, that those who follow their footsteps may possess that information in which they feel their own deficiency.

It is to the rising generation that we must principally look for improving the practice of husbandry by a due attention to its *principles*; and this can only be brought about by instilling into the minds of those at least amongst their number who look forward to the management of large estates, either of their own or of others, the elements of physical science, at a period of life when the attention is most awake, and the thoughts unoccupied by more imperious duties.

It is remarkable that, of all the nations of civilised Europe, England is perhaps the only one which is destitute of any public establishment for the instruction of those designed for agriculture, although two centuries ago the poet Cowley was alive to its importance, as, in one of his prose essays, he strongly recommends the erection of a College in each of our Universities, for the express purpose of educating those who were to be trained to husbandry in the several arts of aration, pasturage, gardening, and rural economy.

In France the establishment of Grignon, near Paris, supplies means of instruction for more than a hundred pupils in the elements of physics, in chemistry, in botany, in other branches of natural history, and in the veterinary art. In the kingdom of Wirtemberg, that of Hohenheim near Stuttgard, to which is

assigned one of the royal palaces, provides a still more complete course of education of a similar kind. In Bavaria, in Prussia, in Lombardy, and in the Tuscan territory, the respective governments have evinced an equal solicitude for the same end; and even Ireland has in this respect taken the start of ourselves by the foundation of a school of agriculture.

In these and similar institutions theory goes hand in hand with experience, and the practical management of a farm alternates with, and illustrates the lectures of the professors. It is therefore the more a matter for surprise, as well as of regret, that in this country, where the demands of a rapidly increasing population ought to tax to the utmost the skill and invention of husbandmen, the student in agriculture finds himself often compelled, from the want of similar provisions of a public nature, to serve his apprenticeship in the art in parts of the country offering no facilities whatsoever for the acquisition of scientific knowledge.

Should, however, as it may be hoped will happen, this glaring deficiency in our provisions for national instruction be hereafter supplied, we must not flatter ourselves that by its means the great body of those actively engaged in agriculture will acquire the leisure and science necessary for solving those many intricate problems that lie on the very threshold of agricultural chemistry. To determine, for example, in what precise manner the several artificial manures operate upon the crops; by what agency and under what circumstances the latter are enabled to decompose them, and how far one of them admits of being substituted for another, are tasks, each of which demands, not only a profound acquaintance with modern chemistry, but likewise a devotion of time and of attention not often compatible with active occupations. And whilst the wealthier agriculturist would be discouraged from the prosecution of such experiments by the above considerations, men of moderate means may also be precluded from undertaking them by the pecuniary sacrifices with which they would be necessarily attended. Considering, therefore, the great national importance of many of these inquiries; the immense increase in the produce of the country that would accrue from any discovery, however inconsiderable, in the principles of husbandry; and the difficulty of meeting in any one individual with that union of science, perseverance, capital, and devotion, both of time and money, which such experiments involve; the supplying means for carrying them into effect would seem to be precisely one of those objects, which should engage the attention of societies of men combined together with a view to the advancement of agriculture.

It is on these grounds that I think much advantage would be

derived from the establishment, under proper management, of an Experimental Farm—not that I would discourage the great body of farmers from making such experiments as they may feel themselves equal to, or deny the necessity of repeating the same operations on various *kinds* of land before their advantage can be regarded as sufficiently tested; but that I conceive there are many trains of research which will never be attempted, or, if attempted, will never be successfully carried out, without such an auxiliary.

The foundation indeed of an experimental farm, under the auspices of this Society, or of more than one, if the zeal of the leading agriculturists could be sufficiently awakened to raise the requisite funds, has been long and anxiously desired by many persons of great practical experience in agricultural matters;* and I cannot but think that if each of them were conducted by an experienced supervisor, who should be expected to carry into effect the views and suggestions of such men of science as may have directed their attention to the theory of agriculture, those deficient links would shortly be supplied, which, even if considered in themselves unimportant, are nevertheless necessary parts of the chain which serves to connect our theory with our practice.

If in juxtaposition with each of these establishments on which new methods of culture were tried, and the precise operation of the various manures worked out, there was founded a model or example farm for exhibiting the most approved system of husbandry now in use, every discovery that should be announced as having been brought to light at the former might undergo the further test of being repeated at the latter, before it received the final impress of the Society's sanction.

And let it not be supposed that either the model-farms which are already instituted, or which may hereafter be set on foot under the auspices of any public Body, such, for instance, as the Society I am now addressing, could supersede or take the place of one designed for agricultural experiments.

Since a model-farm, in order to serve as an example to the neighbourhood, must be conducted with a view to profit, all new schemes of cultivation which do not carry with them on their very face a reasonable probability of advantage must be necessarily rejected; and yet, where the object is one of national and not of individual gain, the discovery of a single new fact would compensate for a hundred unsuccessful trials. If experiments are divided into those which produce *fruit*, and those which elicit *light*, it is

* I may instance, in particular, Sir Francis Mackenzie of Gairloch, Bart., who has been urgent in his solicitations, first to the Highland Society, and since, as I understand, to the Royal Agricultural Society of England, to establish Experimental Farms in both countries.

evident that the former only can be expected to meet with attention on farms which are either in the hands of individuals, or which are intended as examples for their imitation; but as the distinction made by Lord Bacon by no means implies that the latter class of experiments is barren, but only that the fruit they bear is of tardier growth, this Society could not be accused of losing sight of those practical ends for which it was instituted, if, in the spirit of the instructions of the great Restorer of Learning, it sought for experiments which afford light, even in preference to those which promise immediate profit.

A Society like this, indeed, may be said to bear the same relation to an individual Proprietor which the latter does to the Tenant at will; and as the prospect of a remote and contingent advantage often stimulates the landlord to embark his capital and labour on improvements which the yearly occupant would reasonably shrink from engaging in; so a still more far-sighted view of future benefit to the community, and a more enduring interest in the welfare of this mighty empire, may justify a Body of men like that to which I now appeal in instituting experiments of a description such as few individuals could be induced to undertake.

TABLE I.—Classification of Soils, extracted, with a few trifling alterations, from Schöbler's *Work on Agricultural Chemistry*.

Names of the Different Descriptions of Soil.			Proportions of Ingredients in every 100 Parts.				Agricultural Designations and general Relations with reference to their Produce.*
Classes.	Orders.	Species.	Clay.	Lime.	Humus.	Sand.	
1. ARGILLACEOUS SOILS. Above 50 per cent. of Clay. More than 5 per cent. of Lime.	Without Lime.	Poor . . .	Above 50	0	0.5 to 0.5	The Remainder.	<i>Land for Wheat and Spelt.</i> The calcareous kinds not too rich in clay, and not too poor in sand and humus, give good returns. Wheat, spelt, barley, rape, beans, flax, and clover flourish in it especially. Those poor in humus are still suited for oats.
		Intermediate { Rich . . .	" 50 " 50	0 0	0.5 to 1.5 1.5 to 5.0		
	With Lime.	Poor . . .	Above 50	0.5 to 5.0	0* to 0.5	—	
		Intermediate { Rich . . .	" 50 " 50	0.5 to 5.0 0.5 to 5.0	0.5 to 1.5 1.5 to 5.0	—	
2. LOAMY SOILS. Not more than 50 nor less than 30 per cent. of Clay. Not more than 5 of Lime.	Without Lime.	Poor . . .	30 to 50	0	0* to 0.5	—	<i>Land for Barley.</i> The soils which are rich in humus, and contain lime, are well suited even for wheat and spelt, and often approach nearly to the foregoing kinds. They are, moreover, suited for Triticum diocetum? (Emmer), one-grained wheat (Einkorn), rye, oats, rape (Raps), flax, and clover.
		Intermediate { Rich . . .	30 to 50 30 to 50	0 0	0.5 to 1.5 1.5 to 5.0		
	With Lime.	Poor . . .	30 to 50	0.5 to 5.0	0* to 0.5	—	
		Intermediate { Rich . . .	30 to 50 30 to 50	0.5 to 5.0 0.5 to 5.0	0.5 to 1.5 1.5 to 5.0	—	
3. SANDY LOAMS. Not more than 30 nor less than 20 per cent. of Clay. Not more than 5 of Lime.	Without Lime.	Poor . . .	20 to 30	0	0* to 0.5	—	<i>Land for Barley and Oats.</i> Less suited for wheat and spelt than the former soils, but even better adapted for Triticum diocetum and T. monocetum, as well as for rye. Potatoes, turnips, and other roots thrive well in it.
		Intermediate { Rich . . .	20 to 30 20 to 30	0 0	0.5 to 1.5 1.5 to 5.0		
	With Lime.	Poor . . .	20 to 30	0.5 to 5.0	0* to 0.5	—	
		Intermediate { Rich . . .	20 to 30 20 to 30	0.5 to 5.0 0.5 to 5.0	0.5 to 1.5 1.5 to 5.0	—	
4. LOAMY SANDS. Not more than 20 nor less than 10 per cent. of Clay. Less than 5 per cent. of Lime.	Without Lime.	Poor . . .	10 to 20	0	0* to 0.5	—	<i>Land for Oats and Rye.</i> Barley thrives well in those rich in humus. They are also well suited for buckwheat. Wheat, spelt, and clover do not succeed.
		Intermediate { Rich . . .	10 to 20 10 to 20	0 0	0.5 to 1.5 1.5 to 5.0		
	With Lime.	Poor . . .	10 to 20	0.5 to 5.0	0* to 0.5	—	
		Intermediate { Rich . . .	10 to 20 10 to 20	0.5 to 5.0 0.5 to 5.0	0.5 to 1.5 1.5 to 5.0	—	
5. SANDY SOILS. Not more than 10 per cent. of Clay. Less than 5 per cent. of Lime.	Without Lime.	Poor . . .	0* to 10	0	0* to 0.5	—	<i>Land for Rye.</i> Of less value: often cultivated only every third year, and the poor land often not at all. Those containing humus are chiefly fit for buckwheat, oats, hemp, tobacco, potatoes, and spargula arvensis.
		Intermediate { Rich . . .	0* to 10 0* to 10	0 0	0.5 to 1.5 1.5 to 5.0		
	With Lime.	Poor . . .	0* to 10	0.5 to 5.0	0* to 0.5	—	
		Intermediate { Rich . . .	0* to 10 0* to 10	0.5 to 5.0 0.5 to 5.0	0.5 to 1.5 1.5 to 5.0	—	
6. MARLY SOILS.	Argillaceous.	Poor . . .	Above 50	5 to 20	0* to 0.5	—	Chiefly suited for wheat and spelt, together with lucern and suifoin.
		Intermediate { Rich . . .	" 50 " 50	5 to 20 5 to 20	0.5 to 1.5 1.5 to 5.0		
	Loamy.	Poor . . .	30 to 50	5 to 20	0* to 0.5	—	
		Intermediate { Rich . . .	30 to 50 30 to 50	5 to 20 5 to 20	0.5 to 1.5 1.5 to 5.0	—	

More than 5, not more than 20 per cent. of Lime.	Belonging to the Sandy Loams.	Poor . . . Intermediate Rich . . .	20 to 30. 20 to 30. 20 to 30.	5 to 20. 5 to 20. 5 to 20.	0* to 0.5 0.5 to 1.5 1.5 to 5.0	Barley and oats.
	Belonging to the Loamy Sands.	Poor . . . Intermediate Rich . . .	10 to 20. 10 to 20. 10 to 20.	5 to 20. 5 to 20. 5 to 20.	0* to 0.5 0.5 to 1.5 1.5 to 5.0	Oats and rye.
	Humous.	Clayey . . . Loamy . . . Sandy . . .	Above 50 20 to 30.	5 to 20. 5 to 20. 5 to 20.	Above 5.0 " 5.0 " 5.0	The humous, and argillaceous, marly soils are amongst the best that exist.
7. CALCARIOUS SOILS. Containing more than 20 per cent. of Lime.	Argillaceous.	Poor . . . Intermediate Rich . . .	Above 50 " 50 " 50	Above 20 " 20 " 20	0* to 0.5 0.5 to 1.5 1.5 to 5.0	The argillaceous soils often approach in value to the argillaceous marls; the remaining orders of both these classes equally correspond one with the other; to the most valuable belongs, as in the former case, the humous. Those wanting in humus require much manure. Those rich in clay are well suited for spelt and wheat; oats, Triticum dicoccum, lucern, and sainfoin thrive in them. Their value is much decreased by containing an excess of lime.
	Loamy.	Poor . . . Intermediate Rich . . .	30 to 50 30 to 50 30 to 50	" 20 " 20 " 20	0* to 0.5 0.5 to 1.5 1.5 to 5.0	
	Belonging to the Sandy Loams.	Poor . . . Intermediate Rich . . .	20 to 30 20 to 30 20 to 30	" 20 " 20 " 20	0* to 0.5 0.5 to 1.5 1.5 to 5.0	
	Belonging to the Loamy Sands.	Poor . . . Intermediate Rich . . .	10 to 20 10 to 20 10 to 20	" 20 " 20 " 20	0* to 0.5 0.5 to 1.5 1.5 to 5.0	
	Sandy.	Poor . . . Intermediate Rich . . .	0 to 10 0 to 10 0 to 10	" 20 " 20 " 20	0* to 0.5 0.5 to 1.5 1.5 to 5.0	
	Pure.	Poor . . . Intermediate Rich . . .	0 0 0	" 99 " 98 " 94	0* to 0.5 0.5 to 1.5 1.5 to 5.0	
	Humous.	Clayey . . . Loamy . . . Sandy . . .	Above 50 30 to 50 20 to 30	" 20 " 20 " 20	Above 5.0 " 5.0 " 5.0	
	Soluble mild Humus.	Clayey . . . Loamy . . . Sandy . . .	Above 50 30 to 50 20 to 30	With or without Lime.	Above 5.0 " 5.0 " 5.0	
	Insoluble carbonized or acid Humus.	Clayey . . . Loamy . . . Sandy . . .	Above 50 30 to 50 20 to 30	With or without Lime.	5.0 " 5.0 " 5.0	
	Insoluble fibrous Vegetable Matter.	Bog and Peat Earth.	With Lime. Without Lime.	" 5.0 " 5.0	" 5.0 " 5.0	

* This of course chiefly applies to the soil and climate of Germany.

TABLE II.—Of the Constituents of Crops.

	VOLATILIZABLE INGREDIENTS—in lb.		FIXED INGREDIENTS—in lb.											
	Water and Carbon.	Azote.	Potass.	Soda.	Lime.	Magnesia.	Alumina.	Oxide of Iron.	Oxide of Manganese.	Silica.	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Total of Fixed Ingredients.
Wheat . . . Triticum vulgare . . .	97,625	238	225	240	96	*690?	26	trace	trace	400	50	†400?	10	2137
Wheat-straw . . .	96,452	30	20	29	240	32	90		..	2870	37	170	30	3518
Barley . . . Hordeum distichum . . .	97,449	202	278	290	106	180	25	trace	..	1182	59	210	19	2349
Barley-straw . . .	94,730	26	180	48	554	76	146	14	20	3856	118	160	72	5244
Oats . . . Avena sativa . . .	97,200	222	150	132	86	67	14	40	..	1976	35	70	10	2580
Oat-straw . . .	94,224	36	870	2	152	22	6	2	2	4588	79	12	5	5740
Maize . . . Zea Mays . . .	98,488	200	200	250	35	128	16	trace	..	434	17	224	8	1312
Maize-straw . . .	95,800	229	189	4	652	235	6	4	20	2708	106	54	6	3967
Rye . . . Secale cereale . . .	98,731	229	532	122	122	44	24	42	34	164	23	46	9	1040
Rye-straw . . .	97,187	20	32	11	178	12	25		..	2297	170	51	17	2793
Potatoes . . . Solanum tuberosum, the tubers	99,006	180	390	234	33	32	5	24	..	84	54	40	151	814
Beans . . . Vicia faba . . .	97,351	513	415	816	165	158	34	traces	..	126	89	292	41	2136
Bean-straw (dry) . . .	97,879		1656	50	624	209	10	7	5	220	34	226	80	3121
Vetches . . . Vicia sativa . . .	97,710		897	622	160	142	22	9	5	200	50	140	43	2290
Vetches (the straw) . . .	94,899		1810	52	1955	324	15	9	8	442	122	280	84	5101
Peas . . . Pisum sativum . . .	97,128	408	810	739	58	136	20	10	..	410	53	190	38	2464
Pea-straw . . .	95,029		235	traces	2730	342	60	20	7	996	337	240	4	4971
Lucern . . . { Medicago sativa, in a green state = 27,000 when dry }	97,390	30	362	166	1304	94	8	8	..	90	109	353	86	2580
Sainfoin . . . { Helysarium onobrychis, in a green state = 24,000 when dry }	98,329	166	494	105	527	69	16	traces	..	120	82	220	382	1671

about 50 tons of

BOUSSINGAULT.														SPRENGEL.																
Water and Carbon.		Azote.		Potass.		Soda.		Lime.		Magnesia.		Alumina.		Oxide of Iron.		Oxide of Manganese.		Silica.		Sulphuric Acid.		Phosphoric Acid.		Chlorine.		Total of Fixed Ingredients.				
Red Clover { Trifolium pratense, in a green state = 24,000 dry }	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571		
	Flax Beet					{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	{ 438 1481 3178 }	630 234 234 234	285 139 139 139	2 20 20 20	traces 58 50 50	120 105 105 105	24 123 123 123	880 167 167 167													12 380 380 380	2340 5986 5986 5986
Beet	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571		
Cabbage or Rape	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..
Turnips	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..
Sweedes or Ruta Baga	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..
Cow-Parsnip	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..
Carrots	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..
Comfrey	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..
Buckwheat	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..
Meadow-Catstail	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..
Rye-Grass	98,253	{ 176 when dry 277 }	{ 97,660 93,744 270 fresh gathd. 26 }	{ 84,561 92,542 99,427 }	{ 17 when dry 220 }	419	111	584	70	3	traces	76	94	138	76	1571	..	..	..	..	..	..	..	..	..	..	..

SPRENGEL.

BOUSSINGAULT.

† In Sprengel 40·0, but this is a manifest misprint.

* So in Sprengel, but we probably ought to read 69·0.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

I.—*Application of Blue Shale to the Surface of Land.*

To the Secretary.

SIR,—Every one who has travelled through the coal districts must have observed immense accumulations near the pits of a blue clay-like substance brought up from the mines, called in the West Riding of Yorkshire "*Blue Shale*." The rapidity with which this accumulates, in most instances, makes it inconvenient, and in time it becomes a great incumbrance. It is often burnt, and in that state is found useful for the growth of turnips drilled along with crushed bones; but as the whole of the mass is to turn over before it will burn thoroughly, the burning of it becomes tedious and expensive.

Having a farm, of which many parts are hilly and very thin of soil, without any bed of clay or marl near it, has compelled me to try many experiments to find a substitute for them, and having now some years' experience of the utility of applying this blue shale to the gravelly parts of my farm, I am induced by the success which has attended its application to submit my observations of one experiment (amongst many I have tried) to your Society to show that even this article, which is generally considered not only useless but absolutely a nuisance, may become of value if applied to soils of a gravelly and sandy nature.

The soil upon which I have tried it is that lying upon the magnesian limestone near Ferrybridge, proverbial for its natural poverty and inability to resist drought.

Amongst the experiments I above mentioned I found a great advantage in applying the "*Blue Shale*" on my pastured seeds in autumn previous to ploughing them up for wheat to the extent of 12 two-horse cart-loads per acre. I invariably found it of great use, its effects being visible in the wheat crop, not only from the straw being stronger and longer, but the ear was much better filled and the grain plumper than in those parts of the field where it had not been applied, and its effects were very visible for several years afterwards.* That it was of great use to my land, being thus ascertained, caused me to apply it more liberally; and the result of one experiment of this liberal application I now lay before you.

One of the fields of my farm had been considered for many years of so little value as not to be worth the trouble of cultivating it, and, from the grass-roots dying away in summer on the hilly parts, it was of no value when laid in grass. My predecessor in the farm had suffered this field to lie (once ploughed out of stubble) for several years, until it was

* An instance is now visible where applied in 1833; the field is now wheat, and where the shale was applied appears much more luxuriant.—May, 1842.

overgrown with weeds, twitch, and thistles, which had shed their seeds for years unmolested.

This field is 7 acres, exclusive of the fences, and consists of the sides, or rather the ends, of two steep hills facing east and west, with a valley between them. The hills take up about $5\frac{1}{2}$ acres, the valley the remainder. A great portion of the soil has been washed from the top and sides of the hills, and little has been left more than a mass of small gravel-like stones about 2 inches thick, on the top of about 4 inches of sandy soil.

The substratum is yellowish calcareous sand,* called here marl, but a more inappropriate name could not be given to it—it is very porous; the sides and tops of these hills in a dry season not supporting any vegetation whatever to maturity excepting poppies.

I entered to the occupation of this field in January, 1833, and, the spring being favourable, I was enabled to sow it with white Norfolk turnips in June, giving it 9 three-horse cart-loads of rotten manure per acre, and drilling in with the turnips a compost, made some weeks before, of 14 qrs. of crushed bones, half-inch, and their dust, 10 qrs. of kiln-dust, and 28 qrs. of fine ashes from weeds burnt. These turnips were a complete failure in every part except the valley (swealing away, to use a provincial term, both on the tops and sides of the hills), in which the crop was good, and eaten off with sheep. In 1834 sowed it with barley and small seeds for pasturing, giving it 12 bushels of rape-dust per acre—produce of the whole field, 11 qrs. 3 bushels of barley, or 13 bushels per acre. On the hills a great portion did not shoot into ear. In 1835 and 1836 pastured with sheep; in October, 1836, sowed it with wheat and rye (called here maslin) and 16 bushels of rape-dust per acre; 1837, wheat and rye—produce of the whole field, 9 qrs. 1 bushel, or $7\frac{3}{8}$ bushels per acre. Again the corn badly fed, and the rye scarcely having half-a-dozen grains in an ear.

Being satisfied that giving this field the tillage I was doing, without its producing me some better crops, would not pay me, I determined to cover the hills with “blue shale,” which in other parts of my farm I had found of use; and commenced immediately after harvest, when the carting was good. I had to lead it about one-third of a mile; and in the whole laid upon the hills 287 three-horse cart-loads, at a cost of 11*l.* 11*s.*, viz.—

* I have attempted to improve my farm by an admixture of soils, and have found it by far the *most certain way of making permanent improvements*. The calcareous sand here mentioned, which in the neighbourhood has been considered perfectly poisonous to plants, by mixing it liberally with the soil, I have found to contribute to a considerable increase of my crop.—C. C.

This experiment is interesting, and may lead to others of a similar nature. The great advantage of a mixture of different earths, even of those which are barren in their nature, in improving the fertility of a soil, is as yet but little known. It is of no use to manure highly, until the texture of the soil and its power of absorbing and retaining moisture be ascertained; and the earths which are the cause of the barrenness of one soil, may greatly improve another of an opposite quality, when mixed with it. We know this to be the case with chalk and marl; but much remains yet to be done by a mixture of gravel, sand, peat, clay, and decomposed rocks, and experiments on a moderate scale will throw much light on this subject.—W. L. RHAM.

		£.	s.	d.
4 men, filling and spreading, 6 days, at 2s. 0d. per day		2	8	0
1 do. do. do. 3 days, at 2s. 0d. ,,		0	6	0
2 lads, driving, &c. . 6 days, at 1s. 0d. ,,		0	12	0
11 horses . . . 6 days, at 2s. 6d. ,,		8	5	0
		<hr/> £11 11 0		

I immediately ploughed it in ; and about Christmas I cross-ploughed it. With repeated workings I mixed it intimately with the soil ; and after cleaning it I sowed it in June, 1838, with hybrid turnips, giving it 8 three-horse loads of rotten manure per acre, and drilling on the whole field a compost of 14 qrs. of half-inch bones, with their dust, and 14 qrs. of vegetable ashes, made from weeds, &c., burnt. The crop of turnips was really good. It was eaten off with sheep ; and 250 shearlings were eight weeks upon them, besides the scraps which were eaten by ewes. 1839, barley and small seeds ; produce, 35 qrs. 3 bushels, or $40\frac{3}{4}$ bushels of marketable* barley per acre, weighing 16 st. 3 lbs. per sack of 4 bushels. 1840, pastured with sheep ; in autumn sowed with golden-drop wheat. 1841, wheat ; produce 21 qrs. 6 bushels marketable corn, weighing $63\frac{1}{2}$ lbs. per bushel : thus making an increase in my barley crop of $27\frac{3}{4}$ bushels, and of my wheat $17\frac{3}{8}$ bushels per acre, besides saving the expense of from 12 to 16 bushels of rape-dust per acre in each crop.

I am

Yours respectfully,

*Holmefield House, Ferrybridge,
January 15, 1842.*

CHAS. CHARNOCK.

Last year I tried an experiment on a dry grass-field, laying on one acre 1 cwt. of nitrate of soda, cost 22s., and on another acre 4 qrs. of soot, cost 16s. ; the result was very much in favour of the soot.

II.—*Improved Dibbling-Wheel.*

To the Secretary.

SIR,—Having seen, in the Report of the Council Meeting on the 9th of March, a description of a dibbling-wheel for mangel-wurzel, by William Miles, Esq., M.P., and which consists of only “ONE” wheel, I send you a drawing of a machine which we have used for seven years, with the greatest success, “never having lost our plant” since we used it. It appears that the only difference between it and Mr. Miles’s consists in our using two wheels, which are placed on an axle at any distance apart under 34 inches. Now, if only one wheel is used, and the handles are fixed like a barrow, the man who uses it must of course follow the machine and walk on the ridge, or else by the side of the wheel.

* *i. e.* without the small or light soilings.

Ours having two wheels working upon two ridges (27 inches apart), the man naturally walks in the furrow between them; and, with a very little practice, can use two wheels as easily as one, and of course work two ridges at the same time.

We sow from 3 to 4 lbs. of seed per acre, which enables us to deposit from two to four seeds in each hole, and which of course gives a better chance of a plant than only one.

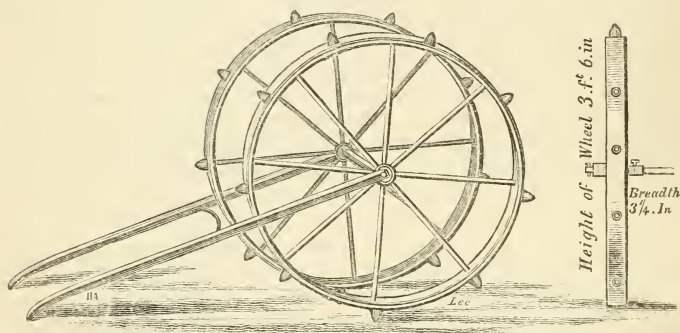
I can only add our entire concurrence in this mode of sowing that very useful root above any other we have yet seen tried.

I am, Sir,

Your obedient servant,

WILLIAM ADAMS, Jun.

*Great Barton, Bury St. Edmunds,
April 15, 1842.*



[It might be an improvement in this implement to set the dib of one wheel opposite to the centre of the interval in the other wheel.]



[The Dibs are 2 inches long by $1\frac{1}{2}$ inch wide at the base, and tapering to a point; and can be set $14\frac{1}{2}$ in., $16\frac{1}{2}$ in., and $18\frac{1}{2}$ in. apart.]

III.—*On the Application of different Manures as a Substitute for Bones in the Growth of Turnips.*

To Henry Handley, Esq.

SIR,—The very high and increasing price of bones having induced me to endeavour to discover a substitute, I send you the result of some experiments made under my own superintendence this season. Soil, a sandy loam, varying from 9 to 12 inches deep, recumbent on a limestone bottom.

The land was fallowed in the usual manner, and ploughed, on the 3rd of June, into ridges 27 inches asunder, and the whole manured with 6 cart-loads per acre of good yard manure, made by bullocks eating oil-cake and straw during the last winter. The ridges were then split, rolled, and drilled with a common one-horse ridge drill, at the rate of 3 lbs. per acre, of purple-top swede and green-top yellow turnips.

The first part of them, with 6 bushels of half-inch bones and dust, at 2s. 9d.; 4 gallons of whale-oil, at 2s. 4d.; and about 40 bushels of ashes, pared from the hedge-sides and burnt.

The second part, with 20 bushels of scutch, at 1s. 6d., and 40 of ashes.

The third, with a mixture of night-soil and cinder-ashes, worked together till sufficiently dry to drill, 20 bushels per acre, with 40 of ashes.

The fourth, with 12 bushels of crushed oyster-shells and 6 gallons of whale-oil, mixed, and 40 of ashes.

The fifth, with 6 gallons of oil and 40 of ashes.

The sixth, with burnt ashes only.

The first and third are decidedly the best, with no perceptible difference between them; the fourth and fifth are equally good; the second and sixth are very much the worst, and very insufficient for the purpose required.

I last year used 2000 bushels of bones; upon the same number of acres I have this year used 200; and, by the substitution of other manures in lieu of bones, I have saved in the first year 125*l.*; and I have, in every respect, to all appearance, as good a crop of turnips. If I have a preference, it is in favour of the night-soil compost; which costs, when made thoroughly ready for use, about 5s. per ton, of 25 bushels.

I remain, Sir,

Your obedient servant,

JOHN MARSHALL.

Riseholme, near Lincoln,

Oct. 29, 1841.

IV.—*On the Drainage of Land.*

To H. Handley, Esq.

Sir,—In a recent article “On the Drainage of Land” published in your Journal, no mention whatever is made of sod-draining, or of drainage with the mole-plough; and thorn-draining is mentioned only incidentally. These drains, though not always so permanent as tile or stone drains, are nevertheless so much cheaper as to deserve further notice.

Of mole-draining I have seen but little; I have never practised it myself. I shall therefore confine my observations to thorn and sod drains: the former of these are applicable chiefly to arable, and the latter to grass lands. I ought to observe that my experience in draining has been confined almost entirely to clay lands—the kind of soil to which these drains are best suited.

Thorn-drains are so generally known as not to need any particular description. They are preferable to tile-drains in this respect, that, being open on all sides to the surrounding earth, they admit the water more freely than tiles do. Where tiles are laid in a tenacious clay, the clay in a wet season becomes so "puddled" round the tiles, as scarcely to allow the percolation of the surrounding water. I have tile-drained seventy acres of land, of which the subsoil was a chalkstone clay. Stubble was laid upon the tiles. During the late wet season the water stood in many of the furrows: the drainage was by no means good. Wherever the furrow had in the course of successive ploughings been carried a foot or more from the line of drain, there the water stood. The drains were not above a foot deep, yet the water could not penetrate; even where an opening was cut from the furrow to the tiles, the water could scarcely gain admission through the intervals of the tiles, so tightly was each interval stopped with clay. Very different was the drainage of about fifty acres of much more tenacious clay which had been drained with thorns. The drainage there was perfect.

Thorn-draining has an advantage over tile-draining in point of cheapness also. The comparative expense of draining an acre of land with each kind of drain may be seen from the following estimate. The prices of labour and of tiles are such as are usually given in this neighbourhood. The quantity of stubble to be laid on the drains, and the number of tiles required for the main drain, would be the same in each case, and are therefore omitted:—

	£.	s.	d.	£.	s.	d.
1500 tiles at 30s. per 1000	2	5	0			
Carriage of do., say 5s. per 1000	0	7	6			
Laying and filling 20 running acres (the running acre is 24 yards) of drains at 6d. per acre	0	10	0			
<hr/>						
Total expense of draining an acre with tiles				3	2	6
One load of thorns, and carriage of do.	1	0	0			
Laying and filling 20 acres of thorn-drain, at 10d. per running acre	0	16	8			
Additional expense of deeper main-drain	0	0	4			
<hr/>						
Total expense of draining an acre with thorns				1	17	0
<hr/>						
Balance in favour of thorn-drains				1	5	6

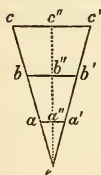
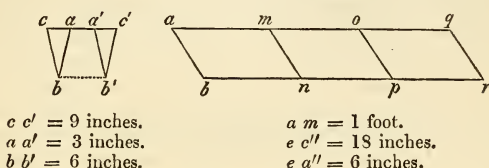
The disadvantages of thorn-drains are, that they are not permanent; and that, being deeper, it is more difficult to obtain a good outfall for them.

The duration of a good thorn-drain depends greatly on the firmness of the soil in which it is laid. When the thorns have perished, the superincumbent clay still forms an arch for the drain. Perhaps fifteen years may be taken as the average duration of a thorn-drain.

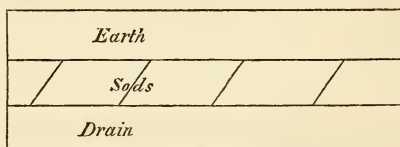
The best materials for such drains are gorse and white-thorn.* The common hawthorn, willow tops, and other materials, are also used. The thorns ought not to be cut till the leaf is fallen, else the dead leaves will encumber the drain.

Sod-draining requires a more explicit description; for, though not unknown elsewhere, it is not, I believe, very generally practised. One mode of sod-draining is by digging a drain about a foot wide, and then doubling the sod into the shape of an inverted V, with the grass inwards. The sods are then laid in the drain, resting on their edges, with the bent middle upwards. I have known drains of this kind to last very many years.

The more common and more effectual way of sod-draining is, however, as follows. The turf along the intended line of drain is cut with a turving spade into a quadrangular shape $c b b' c'$ (fig. 1), 9 inches



Section of a sod-drain.



Longitudinal view of a sod-drain.

wide at top and 6 inches wide at bottom. Narrow wedges, $a c b, a' c' b'$, are next cut off on each side, and thrown aside, leaving the sod about 3 inches wide on the grass side and 6 inches wide underneath. The sods are then raised with a spade, each sod being about a foot long and 6 inches deep. The ends $a b$ (fig. 2), &c. slanting off, so that each sod overlaps its neighbour.

The sod having been thus removed, a "spit" of earth is taken out, and the crumbs are removed with a common draining-scoop. Another spit is then taken out with a narrow spade, and the loose earth is again removed with a narrow scoop, such as is used in making thorn-drains. The drain thus formed is wedge-shaped (see fig. 3), being about 18 inches deep, about 9 inches wide at top, and scarcely an inch wide at bottom. The depth and width of course vary a little, if the level of the surface requires it. In this respect sod-drains have an advantage over mole-drains, which must be parallel to the level of the surface. They may therefore be carried over ridges and other inequalities where the mole-plough would be unavailable.

The sod is next placed in the drain with the grass-side downwards,

* Alder is very durable; heath and black-thorn probably the most durable of all.

each sod lapping over the end of its neighbour (see fig. 4), and the drain is filled up with earth. The sod, if carefully cut, fits closely into the drain. It will bear a great weight: indeed the greater the weight upon it the more closely it is wedged down against the sloping sides of the drain. In this respect our drains seem to be superior to those made with ledges or shoulders to support the sod; for in such drains the weight rests chiefly upon two points, whereas in our wedge-shaped drains the whole of each side shares in the pressure.

Where the soil is tender, the drain is made a little larger, and a larger sod is filled in; or a few thorns are placed in the drain to support the tender earth. In sand or gravel-beds, or other very bad places, it is well to lay tiles as far as the soft soil extends. In very wet furrows it is well to cut the drain a little on one side of the furrow, for both the soil and the sod are generally sounder there.

Drains of this kind, if carefully made, last many years. In the only case in which I have known well-made sod-drains require to be renewed, they had lasted about twenty years. In cutting ditches, sewers, &c., I have lately fallen in with sod-drains considerably more than twenty years old, which were as sound as when they were first made. The usual price per acre (of 24 running yards) for making sod-drains is 10*d.*, and 1*s.* per running acre for the main-drains. Where the soil is stony I have given as much as 1*s.* per acre for the sod-drains, and 1*s.* 6*d.* for the main-drains. In counties where labour is cheap the expense would probably be less.

The expense of draining an acre of land with sods may be estimated as follows:—

	<i>s.</i>	<i>d.</i>
20 running acres of sod-drain, at 10 <i>d.</i> per acre	16	8
Tiles for main drain, say	1	4
Laying do. at 1 <i>s.</i> per 24 yards, say	0	6
Total expense of sod-draining an acre of land	18	6

No stubble or other material is required to lay upon the drains. According to this estimate the expense of draining with sods is less than a third of the expense of draining with tiles. Supposing sod-drains to last twenty years, the interest of the money saved by substituting sod-drains for tile-drains will more than pay the expense of renewing the sod-drains *ad infinitum*.

I have drained between sixty and seventy acres with sod-drains, and so well am I satisfied with them, that I intend to drain about as much more in the same way.

I am, Sir,
Your obedient servant,
H. H. BROWN.

Heckington, Feb. 23, 1842.

NOTE—I drained some clay land in the year 1814 in this way, and very little of it has required to be renewed.—SPENCER.

THE
JOURNAL
OF THE
ROYAL AGRICULTURAL SOCIETY
OF ENGLAND.

VOLUME THE THIRD.

1842.

PARTS II.—III.:
COMPLETING THE VOLUME.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.

MDCCCXLII.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

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ERRATA.

PART I.

In Mr. Murchison's paper, p. 130, line 21, *for* "hectares" *read* "hectolitres."

PARTS II.—III.

In Mr. Pusey's paper, p. 185, line 10, *for* "36s." *read* "54s."

XIII.—*On the Progress of Agricultural Knowledge during the last Four Years.* By PH. PUSEY, M.P., F.R. and G.S.

As four years have passed since our Society was founded for extending the knowledge and improving the practice of husbandry, it may not be useless now to inquire how far, if at all, its working has hitherto carried out the views of our founders. Though we could not be fairly required to have done much in so short a time, we certainly ought to have done something, strengthened as we have been by the hearty aid of the English farmers. We should be encouraged, I think, by knowing what we have done, if, indeed, we have succeeded in anything; we shall be more likely to advance farther, if we look at the difficulties we still have to deal with; and the best encouragement, perhaps, for active men, is the knowledge that they have yet a great deal to do. The extension of science may, however, mean two different things, either the spread of existing knowledge among a wider number of persons—and this is a most important object in our department; for if the best practice of each different district could become general in the country, a very great improvement in farming would at once be effected—or it may mean the discovery of principles hitherto entirely unknown. In examining how far we have advanced in either way the knowledge of farming, it may be convenient to begin with the soil itself, proceeding afterwards from tillage and seed-time to harvest; and as no soil, however good, can yield what it ought while it is drenched with water, we must first consider drainage.

It is only seven years since we heard in England, chiefly through the present Speaker of the House of Commons, that a manufacturer in Scotland, now well known as Mr. Smith of Deanston, had found the means of making all land, however wet and poor it might be, warm, sound, and fertile, and that this change was brought about by two processes, thorough-draining and subsoil-ploughing. His rule of draining was this: that we are not to endeavour merely to find out hidden springs, and to cut them through by a single drain, which in some of our books appeared to be regarded as all that was necessary; but that, as the whole surface of retentive soils is rendered wet, not by accidental springs, but by the rain, the whole surface of the field must be made thoroughly dry by under-drains, running throughout at equal distances; any field, he said, however wet, might be so dried, provided these under-drains were cut sufficiently near to each other. This was the principle of Thorough or Frequent Draining asserted by Mr. Smith of Deanston in 1835; and this principle, which was then new and startling, may now be regarded as firmly established. But though it was then so novel, I have discovered accidentally that it has been long practised to its fullest extent in one part of

England. I do not speak of furrow-draining, which was well known in many districts, for the drains were not generally so deep nor so numerous as they are on the Deanston system. But an old drill-man from Suffolk having observed to me, that if he were the tenant of a strong clay farm in this neighbourhood, he should drain the whole of it with drains cut 12 feet apart and 3 feet in depth, I was struck with this remark of an old man who had never read the new system of drainage, yet described it as carried to its utmost extent, for drains could scarcely be cut nearer or deeper. He told me, on being further questioned, that it was the method which he had seen as a boy at his native place. Mr. Allan Ransome, at my request, inquired into the matter, and informs me that forty years ago three properties, one of them Lord Huntingfield's, near Yoxford, in Suffolk, were drained in this manner. I have reason to believe that the same effectual mode of draining has long been practised in Essex, so much so as to be called the Essex system even in Scotland. Now, in proving that Mr. Smith's system is not new, I do not lower his claims to our thanks, for he probably invented it also, and at all events carried it out with an energy which made it new in his hands; but I think the fact of its previous practice in Suffolk and Essex worth notice for two reasons: one, that any new method, however highly recommended, must be received with doubt as long as it continues new, and that consequently the best praise by which any method can be recommended to practical farmers is, not that it is new, but on the contrary that it is old and tried; the other reason is this, that here was a plan of drainage which was regarded as novel, yet had been employed and established for half a century at no great distance from London; and this is by no means a singular proof how little the farmers in one part of England knew, until lately, what the others were doing.

All, however, who are at all acquainted with improved husbandry are now agreed that on wet land thorough-draining is to a farm what a foundation is to a house. There is no doubt now what ought to be done; the difficulty is to find means for doing it, since one-third of England, I believe, requires to be drained. It would be easy to bring forward instances of great profit resulting from drainage; and I may refer to the accounts of Sir James Graham's operations at Netherby,* and of Lord Hatherton's† at Teddesley, where the water which gushes out of the underground drains is thrown over a water-wheel, threshes the corn, and does the other work of the barn; still great returns cannot be held out in all cases, yet every wet farm ought to be drained. But the advantage of draining is not to be measured

* Journal, vol. i. p. 32.

† Ibid., vol. ii. p. 273, on the Drainage of Land: by J. F. Burke.

merely by the additional bushels of corn that may be grown on an acre; though I believe five or six bushels of wheat per acre would be a fair estimate of the increase; for such land is usually thrown up into very narrow ridges, perhaps 10 feet wide, and no corn grows in the bare furrow; so that one-tenth of the land is lost altogether; the lower half of the ridge, too, on each side of the furrow bears often only straggling ears; long tracts of such fields must have been seen between Birmingham and Liverpool last year by many of our members; and it may be useful for landowners to know that every arable field which is laid up in ridges probably requires more or less to be drained; in fact these deep furrows were devised by our ancestors for drying the ridges piled up between them. An intrinsic advantage, however, of draining is this, that the character of the farm is changed. It is difficult to obtain a good tenant for a cold clay farm; and I am inclined to think that some of these farms have gone backwards in the last fifty years. On two such farms, now in wretched condition, I found it was in the memory of living persons that they had once borne far better crops. No long time ago it was the clay lands that fed the country; but since the great change effected in light-land farming by turnip husbandry, every farmer wishes to occupy what is called a stock-farm, a farm where he can fold his sheep on the land at all seasons, consequently the clay-farms have become less and less popular; and, in some cases, have fallen into inferior hands.* Nor can we be surprised at the unpopularity of a wet farm, for its discomforts are endless, as well as its losses. The acts of husbandry are at all times liable to interruption by excess of rain. The farmer does not know when he can plough or sow; often his teams cannot go on the land; so that the work to be done

* A main reason why clay-farms have, to a considerable extent, fallen into "inferior hands" is the circumstance that they are the only farms which, from the moderate outlay required to enter, come within the reach of a certain class. If, for instance, a farming servant or cottager, either by marriage, bequest, or a long course of industry, shall have become possessed of a few hundred pounds, and desire to be himself an occupier, he is debarred from entering upon a grazing, a mixed, or a convertible farm, by the capital necessary to purchase stock or artificial manures; but for a small clay-farm a team of horses and a few implements are alone essential. He ploughs, sows, and reaps, and converts his straw into what he calls manure by the mouths and feet of a few starved calves or yearlings, mainly aided by the winter rains, and then carts it on his land, little better than rotted straw. No wonder the condition of small clay-farms should be low. Yet, however disagreeable the enumerated drawbacks to a clay-farm, and I admit they are many, there is none more grateful for capital expended, either in draining or manure. Once drained, the art of clay-farming consists in the art of ploughing, and the art of making manure. If, on the one hand, the clays could advantageously spare their superfluous moisture to the thirsty, gravelly, or sandy soils, on the other hand, they do not burn, like these, under a summer sun, and at all events carefully retain, until required by the crop, whatever manure is put into them.—H. HANDLEY.

accumulates; yet when the favourable moment arrives, in which all the work must be done at once, he requires more horses for each plough than the light-land farmer, while he has less time for doing that work. In a wet autumn he must sow his wheat too late; perhaps not sow it at all. If he does sow wheat, and the rain continues, the seed sometimes rots in the ground; or if it has come up well, winter soaks the hollows thoroughly, if it does not fill them with standing water; and in spring, on each side of the furrow, large blanks are seen in the crop.*

In fact a perpetual struggle is going on between the ploughman with his horses on one side, who endeavours to reduce this stubborn clay into mould, and the rains which render it solid again. There are some such farms, so hard in dry weather, so tough in their best state of moderate moisture, so deep and impassable in wet winters, so cold and backward in spring—I have one such farm myself—that farmers who are accustomed to warm, sound land, fit at all times for stock and for labour, say they would not occupy such ground free of rent. No one who knows the effect of thorough-draining can see without regret such farms, and the starveling crops which they bear. If the occupier be a bad farmer, his own circumstances are probably in proportion to the poverty of his land; if a good one, half his exertions are lost, and he does not obtain the fair reward of his industry and enterprise. If I were a working-farmer, nothing would induce me to enter on a cold wet farm, unless there were a fair prospect of its being drained, either with my own money under a long lease, or with the aid of my landlord. Our Society has wisely abstained from entering into questions between landlords and tenants; and I will therefore merely mention that sometimes in Scotland, on a lease for nineteen years, the tenant pays for the draining himself; sometimes the landlord finds materials, and the tenant the labour, or the landlord pays for the whole, receiving interest for his outlay. The landlord, however, may not find it convenient to make heavy advances over a large property; but, as Lord Stanley recommended, he may borrow the money for such a purpose. In districts, indeed, where under-draining is still unknown, the tenant may not be aware of its advantage, and therefore may not meet his views. In that case a few fields may be drained at first, in order to prove the advantage; or if a poor wet farm should fall in, it may be taken in hand and reclaimed, which is more useful and

* I have also heard from a farmer on a very stiff clay that the wetter the winter the more rain is required on such land by the wheat in the following summer, the more consequently it suffers in a season of drought. The reason, I think, must be this, that the water lodged in winter condenses the soil, destroying the looseness which the plough had produced in it, and thus rendering it when dry once more a close clay, through which the roots of the plant cannot make their way, and which moderate summer rains cannot penetrate; but this is not generally applicable to clay lands.

more interesting for a country gentleman than to occupy a farm ready made to his hands because it is the one nearest his dwelling. I am sure a strenuous effort ought to be made for attaining this object. All cannot be done at once; but in justice to our tenants, we ought to begin in earnest, not regarding with indifference farms poached with water, but considering the want of drainage on any part of our property as a defect, and in some degree a discredit. Every land-steward should survey his employer's estate with this special view, lay the result before his employer, and suggest matured plans for drying the soil.

The best materials for draining are tiles: indeed, where the fall is slight, the water does not flow through broken stones; and if the stones must be brought from a distance, the labour of drawing them is too heavy. Hitherto, however, the cost of tiles has been a great check to their employment; but two years ago we discovered that while 40*s.*, 50*s.*, and even 60*s.* per thousand were paid for tiles in the south of England, Mr. Beart, of Godmanchester, five years before had invented a simple machine by which he had reduced the price of tiles from 40*s.* to 22*s.* throughout Huntingdonshire. His statement was as follows:—

“The price of furrow-draining tiles has fluctuated here from 20*s.* to 22*s.* per 1000: at these reduced prices the consumption of tiles has increased greatly. As a proof of that increased consumption, and of the great quantity manufactured, it was publicly stated at a late meeting of agriculturists at Huntingdon, that one tenant-farmer last year consumed 520,000 draining-tiles. I wish to point out to tile-makers, that whether the making of draining-tiles be performed by machinery or by hand-labour only, they may be made at prices much below what they now cost in many parts of the country, and thus enable the makers so to reduce the price of tiles that the consumption will augment as it has in this county. Though the profit on a single thousand of tiles will be less, still the quantity they would sell would be so increased that the profits of their works would be larger. By the introduction of machinery, which led to the change of system in this county, a reduction of 15*s.* per 1000 was effected in one season, and *during the last five years the number of tile-works has been doubled.*”*

The price of tiles depends partly on that of the coals used in burning them. Mr. Beart states that in Huntingdonshire, where coals cost 23*s.* per ton, tiles are sold for 22*s.*; and that with one ton of coals he burns 3500 tiles. Where coals then cost 16*s.*, tiles would cost 20*s.*; and where 37*s.*, 26*s.* per thousand. At our Bristol meeting a new tile-machine was shown by Mr. Irving; it is praised by our Judges, and described in this Journal by Mr. Ford, whose estimate of the cost of labour in tile-making agrees closely with Mr. Beart's. Lord Tweeddale's most ingenious machine is also now reduced in size, so as to be worked by

* See account of Mr. Beart's machine, Journal, vol. ii. p. 93.

hand-labour. Those who wish to make tiles will determine for themselves which is the best. Mr. Burke entertains, and has expressed in a note,* a decided opinion; but I need not enter into

* The owners of all tile-machines severally profess theirs to be the best. I am not personally interested in any of them; but having written on the subject, and not only made anxious inquiries regarding it, but also practically examined several of the tiles in different parts of the kingdom, I unequivocally state that those made under the Tweeddale patent are superior to all others; for they are made at one operation, by the uniform power of machinery, the compression of which renders them more solid, and consequently more durable, than those made by hand. In saying this, I have no wish to detract from the merit of Beart's invention; but the so-called "*machine*," though useful in the preparation of the clay, is, in fact, a mere *tool*, and goes no farther; the tile being actually made, as in every other case (except the Tweeddale), entirely by hand. In comparing the price of tiles and soles, the *length* is seldom named, and they are usually not longer than 12 inches: now the Tweeddale tiles are *fifteen inches*; wherefore, the number required by Beart's tiles, at the closest distance of drainage, is 2440, whilst those of the Tweeddale patent would only be 1952. The price of the latter, as I learn from the patentees, varies, according to the price of coals, from 25*s.* to 45*s.* per thousand. The cost of draining an acre could, therefore, never be much more than that of Beart's, while the difference, both in quality, labour in laying down, and real usefulness, would be still greater than in quantity.

It is false economy to drain land with inferior tiles. They may suit the object of a tenant who looks only to the duration of his lease; but the owner of the soil, who has at heart his own interest and that of his heirs, should see that the work is done in the most substantial and imperishable manner. The saving of a few shillings in the price of the tiles is to him, therefore, not worth consideration; and I should imagine that landlords and trustees, when raising money for that purpose under the Drainage Act, will be compelled by the Court of Chancery to use the most efficient means in their power. The subjoined letter from the agent to the Tweeddale patentees will afford all the necessary information regarding the price and formation of their tiles.—J. FRENCH BURKE.

"I understand that you want some information in regard to the improvements recently patented in the Tweeddale drain-tile and brick machinery, and as those additions are of very great importance to agriculturists, as well as to the trade, I have much pleasure in complying with your wish.

"The Tweeddale machinery, in its original state, was intended to perform several functions in the manufacture of bricks and tiles beyond what were absolutely necessary in most cases. In consideration of those objects it was indispensable to employ great *power* to work the machines, and the expense was consequently, perhaps, too heavy for general adoption. On this account the Company instituted a series of experiments, and at much outlay have effected the important result of,—1st, a considerable reduction in the price of the machinery; 2nd, a vast abatement in the patent dues on seignorage; and, 3rd, a diminution of power from that of horses down to the labour of one man, or even a boy. Hence I can confidently assure you that, in the essential points of *quantity*, *quality*, and *cheapness* (length for length), it is utterly impossible for any other existing machine to compete fairly and successfully with those of this Company. Among other advantages, I would beg leave to mention that our machinery, as now arranged, may be profitably adapted to the very smallest establishment; that it may be worked by one person as easily as a grindstone; that it is portable; and that bricks and tiles, of the best kind, can be produced by ordinary labourers and boys.

that question. Whichever of the three be the best machine now, there is no doubt that, seven years ago, Mr. Beart greatly reduced the price of tiles in Huntingdonshire. Here we then paid 50*s.*, and even 60*s.*, for tiles; there Mr. Beart sold tiles of the same length (1 foot) and the same quality for 22*s.*: here soles, one of which is required with every tile, cost 30*s.*; there, from 8*s.* to 10*s.* So that, in fact, for the same sum which the soles alone cost us here, the Huntingdonshire farmer *obtained the tiles into the bargain*. Yet the price of coals would justify a difference of 1*s.* only. If the Huntingdonshire scale could be made universal, the highest price of one-foot tiles would be not 60*s.*, but 27*s.* per 1000: and what has been done in that county for seven years, being now known, ought to be imitated. Indeed, if a landowner have a kiln of his own, he may make tiles, as Mr. Beart does, for 15*s.* per 1000: the machine costs only 12*l.*, and can be used by a common labourer; as doubtless can Lord Tweeddale's and Mr. Irving's. I will only add a short estimate of the expense of tile-draining on the Huntingdonshire scale of prices,—in a district where coals cost 16*s.*, and tiles would sell, consequently, at 20*s.*, soles at 10*s.* Those who know the necessity for draining wet land, the difficulty of defraying the expense where hundreds or thousands of acres require to be drained, and consequently the importance of saving 4*l.* or 5*l.* per acre in making land dry, will agree, I think, that if

You are probably aware that tiles and soles, of 10 and 12 inches in length, are often named in comparison of price with ours, which are not only 15 inches long, but also of very superior quality. It may indeed be some evidence of their estimation in the agricultural world to state that we have this year made *upwards of 20 millions of draining-tiles and soles*.

"I beg to enclose for your attention a short account of our machines, and the rates of seignorage for their use. I shall have much pleasure in showing the hand-machines at work to you or your friends at any time, and to give any information as to the cost of working them. I wish it to be understood that we find no fault with any other tile-machine, but claim only for our own that superiority which we are certain it deserves. The very great durability of our tiles, arising from the compression employed in their manufacture, may be the more readily understood by comparing the weight of the common tile with those made with the aid of the pressure we employ. It will be found that common tiles weigh about 35 cwt. per 1000; while those made by us will weigh about 45 cwt. per 1000. The price of a hand tile-machine is 45*l.*; and with it two men and one boy can easily make 500 perfectly-formed draining-tiles, 15 inches long, per hour.

"The following are the rates of seignorage charged to licencees:—

	Per 1000.	
	<i>s.</i>	<i>d.</i>
On any number up to 100,000, made in any one season .	1	0
On all beyond the first 100,000 up to 150,000, made in the same season	0	11
On all beyond the first 150,000 up to 200,000, made in the same season	0	10
On all beyond 200,000, made in the same season	0	9
On soles for draining-tiles one half the above rates."		

the manufacturers remember the names of men who have improved their machinery, Hargreaves or Arkwright—even though their inventions may have been long superseded—we must not forget what we owe Mr. Beart for his, which is still producing tiles at half cost. The fourth column shows the outlay required for tiles at the high standard—50*s.* for tiles, and 30*s.* for soles.

COST OF THOROUGH-DRAINING ONE ACRE AT HUNTINGDONSHIRE PRICES.

* Distance between Drains.	Length of Drains in 1 Acre.	Number of Tiles.	Cost of Tiles and Soles at high prices.	Reduced Cost of Tiles and Soles.	Cost of making Drains at 3½ <i>d.</i> per Pole.	Total Reduced Cost per Acre.
Feet.	Furlongs.		<i>s.</i>	<i>s.</i>	<i>s.</i> <i>d.</i>	£. <i>s.</i> <i>d.</i>
66	1	660	53	20	11 8	1 11 4
44	1½	990	80	30	17 6	2 7 6
33	2	1320	106	40	23 4	3 3 4
22	3	1980	160	60	35 0	4 15 0
16½	4	2640	213	80	46 8	6 6 8

At this reduced price of tiles the cost of thorough-drainage certainly no longer appears formidable, for the greater portion of our land which requires to be drained would be laid sufficiently dry by drains cut at intervals of 44, 33, and 22 feet. I know many farms, the whole character and management of which would be permanently changed by drains cut at 33 feet apart; this could be done for the very moderate cost of 3*l.* 3*s.* per acre. The greatest number of drains that can usually occur (16½ feet interval, or 4 furlongs per acre) cost only 6*l.* 6*s.* I must admit, however, that on very strong land it may be necessary to fill in with stones over the tiles, which raises the cost of workmanship from 3½*d.* to 6*d.* per pole, that is, from 1*l.* 8*d.* to 1*l.* per furlong. But, if the ground be sloping, broken stones may be used alone, where they are to be found near at hand. In many districts flat stones are common, which may be set upright in the drain, so as to give the same free current as tiles, without their expense. Mr. Holcomb states that he has used mere wedges of peat,† which cost only 6*s.* per thousand, as substitutes for tiles. The Duke of Rich-

* This calculation has been made by ascertaining the expense of cutting one drain of 40 poles in length; the price of labour being usually calculated per pole: and 40 poles, or 1 furlong, are the length of an acre when the breadth is 66 feet. If the price of labour or the cost of tiles be higher than is rated in the table, an addition must of course be made to the estimate for the single furlong; but when the cost of one furlong is ascertained, the expense of draining at the different distances is easily seen.—For more detailed calculations see Mr. Stephens's 'Book of the Farm,' chap. 28. Some addition may be required for breakage and for main drains. The carriage of the tiles is not included because it is not considerable, and would therefore be done by the ordinary horses of the farm.

† Mr. Pym, however, has found that some peat drains he has made in Bedfordshire have fallen in. The field is subject to floods, which had backed up in the drains.

mond has also applied peat, cut into the circular shape of tiles, for the same purpose. There is a method of draining grass-land called wedge or sod draining, fully described by Mr. Handley Brown in our last Number; in which the roof of the drain is supported by a mere wedge of the natural turf. It is exceedingly cheap, costing in Lincolnshire only 18s. 6d. per acre, at an interval of about 30 feet. I think it must require a strong clay subsoil, as a weak clay would hardly maintain an open passage, but would probably silt in. It is, I believe, an old practice in North Wiltshire, where such drains are executed at a depth of 20 inches for 9s. or 10s. the furlong, so that grass-land is there drained at the very narrow interval of $16\frac{1}{2}$ feet for the trifling expense of 2l. per acre. Mr. Brown advocates the use of these thorn-drains on arable land also, and states that he has known them draw well where the water has lain over tile-drains. But in thorn-draining, sooner or later, the whole work must be done again. Tile-drains are made once for ever, since any occasional repairs would fall into the common management of the farm. His statement, however, that tile-drains will not draw on his land, deserves great attention. I have seen the same failure here in drains only 20 inches deep, on some very strong land; but the clay from the subsoil had been thrown back on the tiles in these drains. In the next field, though the drains were 30 inches deep, yet being covered slightly with stones, and filled in with surface mould, they ran well even after one strong summer rain. Some high authorities tell us that the clay should be pressed down on the tile, and that no water should penetrate the drain from above; but I must say on this much-argued question, that practice, I think, is against them. Still Mr. Brown is no doubt right in saying that there is some land in England so extremely retentive of water, that there may be a doubt whether it can be drained with tiles; and as it is on such land that the expense of tiles is heavy, from the necessary nearness of the drains, it may be well to use the old system of filling with thorns as has been long practised in Suffolk. There the drains are cut to the full depth of 30 inches, a narrow open channel being left at the bottom in the solid clay, a twisted rope of straw forming the roof with thorns or heath over it. This system has been found to answer; and indeed on the strongest clays appears to afford more certainty that the drains will run than the new plan of tile-draining. They last sixteen years, and may be completed for 10s. a furlong, so that 6 furlongs of drains may be allowed to the acre—that is, the drains may be placed so near as even 11 feet to each other—for the trifling expense of 3l. It appears to me a fortunate circumstance that on those very heavy soils where on the one hand the great number of drains which is necessary might raise the expense of even cheap tiles beyond ordinary means, and on the other hand there is some doubt whether tiles

will draw off the water, we should find an old established method of draining, which certainly does draw off the water, which is suited particularly to stiff clays, because the stiffer the clay the longer will an open channel underground remain open, and which is so cheap as to bring our estimates once more within a moderate compass. On such land, therefore, I should recommend thorn or wedge draining, because I think many more farms will be drained at 3*l.* than at 10*l.* per acre. The drain, I am told, is placed by the side of the furrow, not under it, and is not trodden in, as we might fear, on arable land. Not only, however, do tiles and stones fail to act on some very heavy land, but on such land, if under grass, I have been told that drainage when it has acted has even been found injurious; and I mention this because we ought not to shut our eyes to objections, and because nothing I believe has more checked the advance of farming than the unwillingness of eager improvers to admit that their remedies can in any single instance be found to fail. Still, with regard to draining, the exceptions, if any, can be but few. Those large tracts of the country which require drainage can generally be drained easily, and our Society has done a great service to the country by making known the means of draining them with the best and most lasting materials, according to the Huntingdonshire method, cheaply. Further reductions of price I know are in progress. If Lord J. Hay should perfect his invention of concrete draining-tiles, another large saving may be effected. But I trust that the coming winter will not pass by without a vigorous commencement of under-draining throughout the country; for besides the benefit to the farm, draining in its execution, of course, gives great employment to the labourers, who may this year be in much want of employment; and even beyond this temporary relief, every landowner who drains and then breaks up with the plough 25 or 30 acres of indifferent pasture, provides employment throughout future years for an additional family. Notwithstanding the covenants in old leases, I believe that on many farms weak pastures not worth more than 20*s.* an acre might be so broken up after drainage, with advantage to both owner and occupier, and that many village families might be so founded.* At all events, the necessity of draining is so certain that within the next ten years a large part of England

* There are also thousands of acres, perhaps millions, that are at present worse than lying waste, causing whole districts to be unhealthy to man and beast, acres that will not support a goose, or at best a sheep, per acre; some let to farmers at from 2*s.* 6*d.* to 5*s.* per acre, all of which, with little exception, if properly drained and well cultivated in a regular course of alternate husbandry, would increase in value from 150 to 300 per cent., forward the harvest from 14 to 20 days, improve the climate of the country, and add to the produce in a direct ratio to the higher value of the land.—GEO. KIMBERLEY.

will probably be thorough-drained, and at no distant day a soaked field will be as little tolerated as ruined barns or foul crops; but I am anxious to see a great exertion made at once for this national object, and, if I have dwelt too long on the matter, my excuse must be this,—that it is vain to speak of good farming until we have land which deserves to be farmed well. There can be no profit in farming highly land on which stock does not thrive, and on which half the crop may be drowned by one rainy week: wet land is well adapted for slovenly husbandry.

Before we leave wet land I ought to say one word on subsoil-ploughing, but the accounts of its effects are as yet contradictory. It does not appear to suit very light soils, as it makes them too loose, unless indeed there be a retentive subsoil under them, near the surface; nor very strong clays,* since these run together again. As it should only be done after draining, we can scarcely ascertain which of the two operations has produced any improvement that may have arisen. It seems, however, to do most good where the subsoil is a mixture of rubble and clay; and I have heard of one farm of that nature, near Taunton, which had been thorough-drained without benefit, but on which the subsoil-plough produced a large immediate increase of crop. This was a red clay, and it was on a red clay also that Mr. Thompson† found subsoiling to have answered in Yorkshire. It appears to answer best on those parts of the country, the northern and western, where most rain usually falls. I would try it, however, after draining on any strong land; but the original plough seems to me too bulky in its underground parts, as the thick iron sole on which it rests can only be forced through the land by great exertion of the cattle.‡ The implement shown by Mr. Nugent at Bristol must stir the land as thoroughly with its thin deep tines or teeth fixed in a framework above ground. Where the subsoil is very stony a single tine will move it thoroughly. Subsoil-ploughing, however, should be tried cautiously, as in two instances—one a farm near Exmoor, in Somersetshire, where the subsoil is a wet blue slate; the other

* There is great ambiguity in the term clay, as used in different districts: sometimes, when a clay is said to have been reduced to mould by subsoil-ploughing, it turns out to be what those who live upon a strong clay would not consider a clay. A really strong clay when dry has no roughness or grittiness which show the presence of sand, but is smooth like soap, though extremely hard and difficult to break with the hand. If it contain lime it is marl.

† Journal, vol. ii. p. 30.

‡ See the Report of the Judges of Implements. The mechanical construction of this ingenious invention will be improved, I believe, at Lord Ducie's Iron-works. Mr. Gabell, of Crickhowell, works his single-tine subsoil-plough 18 inches deep with two horses.—Journal, vol. ii. p. 421. I have also found my own answer the purpose.—*Ibid.*, i. 433.

a farm also with a stony subsoil—it did permanent mischief. The trial, however, can be easily made, as many common ploughs, if the mouldboard be removed, will serve as well as one made for the purpose. Altogether, though we must not speak too confidently of subsoil-ploughing, I cannot but hope that we shall probably have to thank Mr. Smith of Deanston for this invention, as well as for the zeal and ability by which he has succeeded in restoring the ancient English practice of thorough-draining.

Hitherto we have considered only one defect of land—too great cohesiveness, and consequent retention of too much moisture. There is an opposite fault, however, well known to farmers—too great looseness. This fault may be seen on tracts absolutely barren, as on Bagshot Heath, or on fields under culture, which are termed blowing sands, because the surface-sand drifts in high winds. In different degrees it is a common fault in land, and shows itself by thinness of the corn-crop, shortness of the straw and of the ear. Formerly, indeed, rye was grown on such land instead of wheat. Folding with sheep, pressing and shallow ploughing, diminish the evil, but do not remedy it. The practice of our ancestors was to cover such land with marl, which is usually a strong clay, containing a great deal of lime. Marl was said indeed to benefit the land at first, but to injure it afterwards—to be “good for the father, but bad for the son.” This injury, however, arose, I believe, from improvidence; marl was found to act without dung at first, and the fields which had been marled were consequently tilled without dung until their soil was completely exhausted. It fell into disrepute, and many farmers are perhaps not aware that it is still used largely in England. I have been surprised to find, in the successive numbers of our *Journal*, how often it is mentioned casually by members of our Society. To take first the most striking example: the improvement of the late Lord Leicester’s property, as described by Lord Spencer.* I doubt if that lamented nobleman, with all his enterprise, could have fed oxen where rabbits had previously browsed, as was his just boast, unless those sandy commons had first been made solid with marl. It is used also largely in Bedfordshire on a yellow sand about Woburn.† The practice is general, I believe, in Norfolk, and also in Suffolk, where, at some recent agricultural meeting, a prize was given to the farmer who had drawn the largest quantity in one year—and that quantity, if I am not mistaken, was 10,000 cart-loads. It is mentioned by Mr. Dugdale‡ as existing in Warwickshire; and we have a very good account of an entire farm which had been marled, at Sheriff Hutton § in Yorkshire.

* *Journal*, vol. i. p. 1.

‡ *Ibid.*, vol. ii. p. 259.

† *Ibid.*, vol. iii. p. 233.

§ *Ibid.*, vol. ii. p. 67.

Marl is commonly applied in Cheshire to light soils at the rate of 128 cart-loads to the acre.* I have also had specimens of marl so used sent from the New Forest in Hampshire. The greatest improvement of recent times, the application of clay to peat and peaty sand in Lincolnshire and the wide district of the fens, by which in one instance, as we learn from Mr. Wingate,† on land which had been almost worthless, two white crops had been grown every three years, one of them wheat, yielding 40 bushels per acre,—an unexampled rotation, not used, however, only when the land was fresh, but continued for eighteen years;—this improvement, which equals anything that has been done in Flanders, is another instance of the same principle. It is, therefore, important to examine the facts accurately: as yet, however, we have not the means.

The substance applied is sometimes called marl, sometimes clay. Of the specimens I have received, even those which were called clay, have generally turned out to be marl, for they contained lime, which constitutes the distinction. The difference, however, is important, because marl is a much rarer substance than clay; and if lime be an indispensable ingredient of clay fit for manure, many districts of England must be cut off from this source of improvement. I am inclined, however, to hope that it is not indispensable. One specimen of the Lincolnshire clay which I have examined certainly was not a marl. Again, the Flemings, as Mr. Rham‡ informs us, have converted their sandy desert into one of the most fertile districts of Europe by bringing up year after year 2 inches of subsoil from trenches shifted each year, until they reached a depth of 2 feet. Their sands, I believe, rest often upon a yellow clay, and their fields have in some places the singular appearance of light sand on the surface, while water is standing in the ditches 2 feet below. I do not think that the clay of the Netherlands contains much lime. I have met with an instance of a strong clay without lime in Suffolk, which has been applied to a poor light calcareous soil, and paid itself the first year in the clover-crop.§ Near Reading, too, the same effect has been produced by the clay dug out from the railway on a thin burning gravel. That clay is certainly not a marl. We have also a striking account|| in our last Number of the application of blue shale to a field of gravel and sand, on which dung and bones had equally failed to produce either turnips or barley, yet 50 cart-loads of this shale brought on each acre 40 bushels of barley. Now shale is clay half hardened into blue slate. I do not know

* Mr. Cuthbert Johnson on Fertilizers, p. 271.

† Journal, vol. ii. p. 408.

‡ Outlines of Flemish Husbandry.

§ Prize Essay of East Suffolk Agricultural Association, by Captain Alexander.

|| Journal, vol. iii. p. 161.

whether there was lime in the shale, probably not ; but here is an answer to a question sometimes asked when the admixture of soils is proposed—Is clay better than dung ? The answer is Yes. For on very light land even dung will not produce wheat, but clay will ; and I may now give a case in point, which happened this year on my own land, a piece of barley, containing 12 acres, the soil a poor, loose, peaty sand. When the blade appeared, one-half of the piece looked green and healthy, the other half, yellow and sickly. On inquiry I found that to the thriving portion there had been applied two slight dressings of strong clay (not marl, for it had been examined), amounting only to 50 loads on the acre. The boundary was distinct. But in the middle of the sickly portion was also a square patch of vigorous growth. Here there had been a dunghill one year before. The result at harvest was this, that on the clayed portion there was a thick crop of good colour up to the boundary, and even where a detached heap of clay had been laid ; on the unclayed portion the crop was thin, many of the plants having perished. An acre of each was fairly selected and threshed separately. The unclayed acre yielded $34\frac{1}{2}$ bushels of barley, the clayed acre 46 bushels : so that this lasting improvement of the soil was paid in the first year. Where the dunghill had been, the barley ripened prematurely, was of a dark-brown colour, and the seed was shrivelled. It is commonly said by farmers on our burning land that the better a field has been dressed in the previous winter the worse will the barley be in a hot summer ; and I see that they are right. This amounts to the remark of Mr. Handley, that dung will not benefit land beyond a certain point—will produce not wheat, but straw. It is, I believe, a fundamental principle of agriculture, that each soil has a limit beyond which manure cannot force it, and the principle should never be left out of sight. I would add another rule. Strengthen the soil itself where you are able, and you raise that limit permanently. Corn, especially wheat, requires solidity in the soil. A principal cause of barrenness,* as Mr. Rham has shown us, is coarseness of its particles—I suppose because the rootlets are not in contact with such soil. Marl, I believe, does not act merely by its lime, but corrects this defect by interposing finer particles in the soil. Clay certainly acts in this way. But on this important subject I hope that our practical members will send statements of their experience, and specimens for examination. It is remarkable that, among the many analyses of soils reported by Dr. Liebig, all the fine close sands are fertile, and the coarse loose sands, with one exception only, are barren.

But though clay may act which is not marl, and does not contain lime, there is no doubt that the lime contained in marl is also

* Mr. Rham on the Analysis of Soils.—*Journal*, vol. i. p. 47.

beneficial. In Mecklenburg sandy marl* is used as well as clay marl. In the county of Suffolk there is a loose rubble called craig now largely used by farmers as a dressing for land. The account of its discovery, given in a prize-essay of the East Suffolk Agricultural Society, by Captain Alexander, is so remarkable, that I will quote it at length:—

“I now come to the shelly deposit denominated red craig: it consists of shell mixed with sand and gravel. It is barren in its own nature, and is therefore used, instead of gravel, to form garden-walks; it contains much oxide of iron, and was first discovered to be useful as a stimulus to soils overcharged with sour, black, vegetable deposits, from the following accident. A person was carting some of this craig for a garden-walk, and, in conveying it over a black barren soil, the cart broke down and scattered the contents; the driver, instead of collecting the craig, spread it over the surface where it lay. The field was after this prepared for turnips in the usual way, and, much to the surprise of the occupier, there was a good crop of full-sized turnips where the craig had been cast, while the rest of the field afforded only a miserable crop of stunted growth. By this accident was the application of craig first made efficient; and *it is almost impossible to calculate the increase added to our agricultural produce by this discovery in the craig districts.*”

Such is the origin of a widely-spread provincial practice. On the same loose earth my own neighbours have observed that, where limestone-rubble has lain, or a road has passed, the turnips are better, and they spread rubble upon such land. Mr. Charnock† not only applies clay to sand, but he adds, “I have attempted to improve my farm by an admixture of soils, and have found it by far the most certain way of making permanent improvements. The calcareous (limestone) sand here mentioned, which in the neighbourhood has been considered perfectly poisonous to plants, I have found, by mixing liberally with the soil, to contribute to a considerable increase of my crop.”

There is another ancient practice of the kind, which I mentioned in a former Number‡—the application of chalk brought up from pits dug 20 feet deep, on the chalk hills of Hampshire, and wheeled over the land in barrows to the extent of 2000 bushels per acre; but I was mistaken in calling it an expensive operation, for the usual price is wonderfully low, only 45s. per acre, and I believe I was also misinformed in stating that it is useful where the soil contains chalk already. It is remarkable that the red clay of these hills, though very thin, and resting upon chalk which is pure lime, contains, so far as I can ascertain, no lime at all. Hence the chalk acts probably in two ways,—chemically by supplying the lime which was wanting; me-

* See Mr. Handley's paper in this Number.

† Journal, vol. iii. p. 162.

‡ Ibid., vol. i. p. 1.

chanically by loosening the clay, for its application renders these hills more mellow to work with the plough.* Chalk, I find, is also used largely on the wolds or chalk-hills of Yorkshire, and there it is found to render loose soils more firm.† This is a very cheap mode of transposing soils; but on the coast of Essex, where chalking, as Mr. C. Johnson‡ tells us, is largely practised, it is brought by sea from Kent, and is applied at a rate of from 10 to 30 tons per acre, the poor lands requiring more than the rich; and in the clay districts of Windsor Forest the farmers sometimes bring chalk a distance of 10 miles for the same purpose, at an expense, as Mr. Rham has told me in his own case, of 8*l.* per acre. If it is carted 10 miles, where it costs 8*l.*, certainly not an acre of the hills themselves on which the chalk will act should remain without it, where it can be spread from wheelbarrows for little more than 2*l.* The chalk-hills occupy a large tract in England, but whether the soil be generally so strong or so light as to be benefited by chalking I do not venture to say; we want information on this point also. I have brought forward these cases of admixture of soil, not imagining that a sudden transformation of English soils can be effected at once, but in the hope that, in districts where any such practice is known to be beneficial, as on the fens of Lincolnshire or the hills of Hampshire, it may be applied with increased spirit; that some of these practices, as that of claying or marling, may turn out to be useful in districts where they are not hitherto known; that men of science may explain the action of these materials, and so some light be thrown on the laws of vegetation; and that possibly, as in the case of the overturned load of craig, practical farmers, by observing any casual difference in the verdure or growth of their crops,—for nature or chance are constantly making such experiments, if our eyes were open to mark the effect, or our minds to inquire for the causes,—may be so fortunate as to find some new application of the same principle. There are many other cases in point, such as the use of the honeycomb-stone§ (the lava of ancient volcanoes) as a manure in Devonshire and Scotland, or of peat upon clay-lands|| in Germany and Sweden: those which have been mentioned are enough to show that in this, as in many

* Mr. Thorpe's paper in the present Number.

† This opposite effect of chalk, in loosening Hampshire soils and binding those of Yorkshire, may be explained, I think, as follows:—The chalk, which is lime, mixes with the Hampshire clay, and, expanding in a different proportion during frost, shakes the texture of the soil. On the Yorkshire soil it falls also to powder, and this powder interposed between the coarse particles of soil gives compactness. Mr. Schweizer, of Brighton, has also discovered phosphate of lime in chalk.

‡ Mr. C. Johnson on Fertilizers, p. 262.

§ Journal, vol. iii. p. 27.

|| The present Number, Mr. Handley's paper.

other matters of farming, our practice is in advance of our science.

There is still a practical point of view, however, which strikes me so forcibly, with regard to these common admixtures of soil, that I cannot but shortly advert to it. They are all permanent in their effect, and nevertheless all exceedingly cheap. Chalking land on the hills costs little more than 2*l.* per acre; pays itself often in the second year; and its effect lasts for twenty years. Marling cannot cost more; repays itself as soon; and lasts even longer. Claying the fen-land costs 36*s.* an acre; converts very bad into very productive land; and lasts twenty years. Yet there is a great deal of land in each district to which these improvements are applicable on which they are not practised, although they are permanent, while farmers elsewhere lay out 3*l.* an acre for bones which hardly last above two or three years. It is not that the farmers of these districts have any doubt of the efficacy of each process. Why, then, is not each universally carried out upon every acre of land within its own limits? This is a difficult question to answer. In some degree none of us carry out all that is in our power; but want of capital, or want of confidence in the tenure of farms, are, I suppose, the two principal causes of this omission. Without entering minutely into the remedy, I think the more landowners acquaint themselves with the real merits and real difficulties of farming, the more these two obstacles will be smoothed; and I must say that land-agents might promote such improvements more than they do, if they would make themselves acquainted, not with the theory, which is difficult, and may be mischievous, but, as they easily might, with the common practice of their own neighbourhoods. We have many intelligent agents; but it is an evil that any land-agents should be utterly unacquainted with land. Besides these three cheap and lasting improvements of the soil itself, we have found a still more necessary and almost equally cheap improvement, draining, which, it now appears, can be accomplished by some well-known method or other on all land, at little more than 3*l.* per acre, the cost, as I before said, of a good dressing of bones. Now, as the varied surface of England passes through my mind, I do not see that in any large portion of it one or other of these acknowledged improvements might not be at once put largely in practice, with an absolute certainty of success. The chalk hills span the whole south of the country in four branches. We hear of marling in Norfolk, Suffolk, Warwickshire, Bedfordshire, Cheshire, Yorkshire, and Hampshire. I do not know the extent of the fens; but I have seen the extent of land which empties its waters into Boston Wash stated at a million of acres. As for draining, there is not a county, nor any large proportion of parishes, or even of farms, in which

it ought not to be done. These improvements must cost, no doubt, many millions; but there is no want of idle capital. The misfortune is, that, according to an old remark, I forget by whom made, the capital and the soil of the country are not acquainted with each other. I wish it were a standing rule on every estate, and, if possible, on each individual farm, that some employment should be given every winter to the labourer, by doing some lasting good to the soil.

We may proceed, however, from the soil to its tillage, and first the plough. As more has been done by our Society in the last four years for its improvement than might have been expected with regard to so ancient an implement, I will endeavour to trace the progress of our inquiries. At the time of our foundation, four years back, the Scotch iron swing-plough was stated to be the most perfect form of plough. Lord Spencer having remarked that, from his observation of ploughing-matches, he doubted whether swing-ploughs had any advantage over those with wheels, a prize was proposed by our council for the best essay upon the subject, which was won by Mr. Handley, who applied the draught-gauge for measuring the strain arising to the horses from different ploughs, and found that those wheel-ploughs he tried inflicted the least labour upon the cattle. Following his example, I tried several ploughs in the same manner, and with the same result. It further appeared that there was a much wider difference in the draught of ploughs than had been suspected, and even that, of two ploughs used by two farmers in the same parish and on the same soil, one was heavier for three horses than the other for two; the old Berkshire plough costing the cattle a muscular strain of 23 stones, while Hart's improved one-wheeled plough was drawn by them with an exertion of 14 stones only. One of Messrs. Ransome's was hardly surpassed by Hart's in lightness, and it certainly made better work. The Scotch were the heaviest of the swing-ploughs. The next trial was by Mr. Freeman* at Haverfordwest in South Wales, who set an old Welsh plough of the country against Hart's. Here again the old plough was more severe for three horses than Hart's was for two. The old plough stood at 20 stones; Hart's at 13. The next experiments were made by Lord Tweeddale, and in these the Yester plough equalled Hart's plough in lightness. The next trial was before our judges at Liverpool, whose words I will quote from their Report:†—

“It appears that in almost every case the draught of the wheel-ploughs was less than that of the swing kind; and it must not be concealed that the wheel-ploughs in every case actually turned over more soil than the swing, for the share and sole of the former maintained a

* Journal, ii. p. 105.

† Ibid., p. cxiv., Judges' Report.

flat, horizontal position, whereas all the swing-ploughs leant more or less to the land-side, cutting to a less depth on the right than on the left hand side. Consequently, the furrow-bottoms left by the wheel-ploughs were more even than those excavated by the swing-ploughs."

On this occasion, a wheel-plough by Messrs. Barrett, of Reading, was the lightest, marking 22 stones; Hart's the next, 24 stones; a Scotch and a Northampton swing-plough the heaviest, standing each at 40 stones. I cannot but remark how little our mechanists yet know of the draught of their ploughs, when implements could be brought forward to compete for a prize at a great public meeting, some of which gave as much work nearly for four horses as others for two.

The latest published record of trials* is a very careful set of experiments by Mr. Hannam, of Dorchester, in Oxfordshire. Here again, as in Wales and in Berkshire, the lightest plough stood at 13 stones, the old Oxfordshire plough at 22 stones, the Scotch swing-plough at 20 stones. The lightest plough in this instance was Messrs. Barrett's.

There only remains the interesting report of our judges on the ploughs which competed at our Bristol meeting. There again, it will be seen that the lightest plough was a wheeled one, Mr. Howard's of Bedford, which stood at 22; the heaviest, a Scotch swing-plough, which marked 44; the next heaviest, another Scotch swing-plough, which marked 36; and, in the words of our judges, "it is worthy of note that the resistance of Mr. Howard's two-wheel was less by 4 stones than that of his swing-plough."

From these repeated trials, which have arisen out of Lord Spencer's remark, we may now come to the conclusion that wheel-ploughs, as he suspected, are superior to swing-ploughs, in ease for the cattle, and are also superior in the work they perform; that the Scotch swing-plough in particular is very severe for the cattle; that, since in three country trials the draught of the ploughs was found to differ as two to three—that is, as two horses to three—more attention is required on the part of our ploughwrights to the easiness of their draught; and lastly, that, since in our two public competitions at Liverpool, and again at Bristol, the draught of some competing ploughs doubled that of the winning plough, as if at Epsom one horse had only run half the course when another was winning the Derby, it appears very clearly that our plough-makers, as a body, are not thoroughly acquainted with the qualities of their own implements, otherwise the race could not be so unequal. It may not be useless to them, therefore, that we should inquire what it is in ploughing which constitutes the work of the horses? Some makers appear to think that if their plough is

* Journal, iii. p. 9.

light in weight it will be light in draught; but this supposition is a mistake, as the report of our judges at Bristol will show. The lightest weight of a wheel-plough there stated is that of the plough which was heaviest but one in draught; and the swing-plough worst in draught was the lightest in weight of its class.

	Draught.	Weight.
Howard's wheel-plough, lightest in draught	22 stones.	220 lbs.
Carson's wheel-plough, heaviest but one in draught	32	193
Earl of Ducie's swing-plough, lightest in draught	26	161
Wilkie's swing-plough, heaviest in draught	44	125

This distinction between lightness of weight and of draught should be observed by the makers of ploughs who intend to compete at future trials; and it is satisfactory to the employers of ploughs, since it shows that solid construction of the implement is by no means inconsistent with ease to their horses. Again, if the weight of the plough has little effect on its draught, I believe that the weight of the earth to be raised has not much more—for the furrow-slice, when the plough has severed it, can be turned over by the hand without much exertion; neither can the perpendicular cutting of the earth by the coulter occasion much of the draught in ordinary land, because implements with numerous teeth, each performing a similar cut, can be drawn by four horses. But a plough, when merely drawn along the surface of a furrow, requires considerable force to move it. This arises of course from friction—the resistance of the rough particles of the soil to its progress. If the furrow were coated with ice, a finger would draw the plough. Locking the wheel of a waggon at a descent shows the power of this kind of friction. Before the iron shoe is placed under the wheel the horses may scarcely be able to hold back the waggon; afterwards they may be obliged to pull it: but when the plough is at work, every part of it below ground grates downwards, sideways, or upwards, against the earth, as the shoe of the wheel grinds the road. You must therefore add to the labour of a plough-team when you increase the rubbing surface of the sole or of the mouldboard. Our manufacturers of implements should, I think, therefore inquire whether they may not improve the draught of their ploughs by diminishing the surface of the parts which are below ground. Captain Carr pointed out to me that the draught of a plough is diminished if the coulter be set towards the land-side. The reason must be this,—that the coulter so set prevents that side of the plough from rubbing against the land.

There is another cause of draught, which, though similar, is not precisely the same with friction. In my first trials I found that a plough drawn along a furrow on clay-land in a very wet state

occasioned nearly as much labour to the horses as when actually doing its work. The friction on so smooth a surface as wet clay cannot be much; the strain must be occasioned, I believe, by its adhesion. The strength of this adhesion is shown by the difficulty which a labourer finds in digging strong clay, from its adhering when wet to the back of his spade. On such lands in this neighbourhood a wooden mouldboard is used, the clay being found to adhere less strongly to wood than to iron.* The length of a mouldboard must increase adhesion as well as friction, but practically on clay-land it is impossible to use a short mouldboard, because, if we endeavour to throw such land too suddenly over, it will roll before the plough when it is very wet. This happens sometimes indeed even with the long mouldboards now used on such ground; and consequently it is very difficult to make an improved plough for such clays. But for other soils I think plough-makers will do well to regard diminution of friction as a leading principle of their attempts at improvement, varying its application according to the land which their ploughs are intended to work: for we never can have a standard-plough suited to all descriptions of land. If land be light and free, the plough should be short above ground, that the horses may be nearer their work, and short below, that there may be less friction. Hart's is such a plough; and is now generally used on such land in this neighbourhood: but if you put this plough on strong or stony land, it will rise out of the ground when at work. On strong or stony land a wheel-plough must be long in the beam, that the horses may hold it down when they pull it; and taper in the breast, that it may undermine the obstacles which it meets. Different depths of ploughing again require a different shape of the mouldboard. These, however, are matters for the makers of ploughs: the question for farmers is the advantage to be derived from the use of light ploughs. Where the difference is between the draught of two horses and of three, that advantage is of course very clear: even where it is less, the improvement may bring the plough within the command of two horses, upon land which before was too strong for a pair. Where four horses are the usual team, pair-horse ploughing may be impossible, and its advocates were wrong when they asserted that there is no land which two horses are unable to master. But in many districts, where three horses were the usual number, country ploughing-matches have tended to introduce the two-horse system. On the first occasion

* The same soil which when wet adheres to the plough becomes exceedingly hard when dry, because its particles cohere together, and then the splitting action becomes a source of draught: hence, of course, the difficulty of ploughing most soils when they are dry, which becomes impossibility on a strong clay.

the curtailed team is viewed with some incredulity, but does its work. The next year more pairs come forward. At last the triple team becomes singular in its turn, and ultimately disappears.

Even if the number of horses be not reduced, it is of course right for their sakes and our own to lighten their labour; but there is another point in which lightness of ploughs may be useful. I mean increase of pace; and this is a matter deserving more attention than it has received. It is remarkable that more work is done in a day at plough in the north of England than in many parts of the south. Here $\frac{3}{4}$ of an acre, I believe, is the daily task in winter, whereas an acre is the Scotch amount at that season, and a quarter more as the days lengthen. It is stated, however, by Loudon,* that in Suffolk farmers plough, with two horses, 1 acre a-day on stiff soils, and $1\frac{1}{4}$ to $1\frac{1}{2}$ acre on sands. In Northumberland even 2 acres are sometimes accomplished, I am informed, during the hurry of turnip-sowing. I think our farmers' clubs in the slow-ploughing districts ought to inquire whether this practice of the Northern and Suffolk farmers does not deserve imitation; and I may repeat one circumstance which struck me much in my former experiments, as it appears to bear out quickness of pace. It might be supposed that the more rapidly the plough works the greater would be the exertion of the horses, so that, although more work might be done in a day, the ultimate wear of the cattle would be the same. But I found by the draught-gauge that, when a plough was made to move quicker, though more earth was of course moved, there was no increase in the draught, at least as between the pace of $1\frac{1}{2}$ and of $2\frac{3}{4}$ miles in an hour. Strange as this fact appears, it agrees with what is known by mechanicians, that in many cases the resistance arising from friction does not augment with increase of speed, and it tends to confirm my belief that friction is a principal cause of the labour of ploughing-teams. An example of increase of pace without addition of draught may be found, I believe, in the descent of a carriage with a drag on the wheel. The horses, indeed, who have to cover more ground at plough, have of course to carry their own weight a greater distance each day. But, if they be in good condition and nimble, I doubt if they feel it; and the northern horses appear to me to be naturally quick steppers. The best Clydesdale horses, such as the pair of greys which Lord Derby sent to our trial-ground at Liverpool, or Lord Ducie's browns, which were seen by many of our members at Bristol, appear to unite the merits of our three English breeds—the compactness of the Suffolks, the power of the old Lincolns, and the courage and quickness of the Cleveland race.

* Loudon's *Encyclopædia of Agriculture*, p. 1136.

I have dwelt at great length on the construction of the plough, because each successive trial has shown that it is a subject which rewards our inquiries in practice. Mathematical calculations have been framed for it, but the mouldboard of Lord Ducie's plough, so highly praised by our judges at Bristol, had been cast on the day before the trial from a mould shaped to the actual curve of the furrow-slice: and it may be best thus to fit on the plough to different kinds of soil. There is evidently much to be gained, and a great reduction of horse-labour to be effected. Only we must not go too far by asserting that all land can be worked at all times by two horses only.* Soils differ much too widely in their resistance, as appears from the following numbers, which have been already published,† showing the average draught of numerous ploughs tried by me on three neighbouring farms:—

	Draught.
Sandy loam . . .	17 stone.
Clay loam . . .	30
Strong clay . . .	47

Mr. Hannam too, in his interesting trials, has shown that the same field, in different stages of cultivation, varies widely in its resistance; for he measured the draught of some ploughs during the process of barley-sowing, and the difference with Hart's plough was as follows:—

	Draught.	Furrow.
April 2. Seed-furrow with single horse	9 stones	$2\frac{1}{2} \times 8$
April 3. Breaking up turnip-ground trodden in rain	21	5×9
„ Ditto less trodden	18	5×9
April 20. Ditto drier and harder, with the same plough	25	$5\frac{1}{2} \times 9$

The difference of draught between three farms worked with the same ploughs was one to three, and here on the same field the difference within one month is again one to three. Such variations must encourage active inquiry, but should check hasty conclusions.

There is no doubt, however, that in many parts of the country the third horse might be discarded, and that two horses would be

* Even if two horses could draw the plough in winter on our heavy clay-lands, the surface is so soft that the horse which must necessarily walk upon the unploughed land does great harm by trampling it together. I believe that the best plan upon such farms would be this: to have a plough with two shifting mouldboards, a short iron one for summer use, with two horses abreast, and a long wooden one for wet weather, to be used with three horses walking in line. Both Mr. Bennett of Tempsford, near Bedford, and Mr. Moore of Coleshill have adopted this plan of a changeable mouldboard. The plough should have one wheel in summer, and in winter a *foot*, which clogs less than a wheel.

† Journal, vol. i. p. 219, Inquiry on Draught in Ploughing.

ample for each plough. But it may be said that ploughing is not the only employment of farm-horses, and that if the same number of horses be required as at present for other farming operations, each in their due season, the farmer cannot reduce his horses, since for these operations he will require his present establishment; that his stables must be as full as they are now; and consequently the only advantage of putting two horses instead of three to his plough will be that one-third of his cattle may remain idle at home during the season of ploughing. Now it happens, singularly, that another saving of horse-labour has been proposed, which would precisely meet this emergency. In southern England the harvest is brought home on heavy waggons drawn by three horses; and the dung is carried out on equally heavy carts, to which three horses are also attached: but in Cumberland and the north all this is done with light carts drawn by one horse only. Here we have practice on each side, and certainly there appears no particular reason why three horses drawing three carts should be able to convey more than three horses drawing one large cart only: but the contrary would seem more likely. Still there is a strong opinion on the part of those farmers who use the one-horse cart that their system is best. This is a difficult matter to test; but we have had a paper from a south country agriculturist, Mr. Hannam, who has used one-horse carts for ten years, at Burcott, near Dorchester, in Oxfordshire, and who thus states his own experience:—

“My farm, of 370 acres, was some years ago under very able management, with a strength of twelve horses and six oxen. Just previous to my taking it into my own occupation *sixteen* horses had been employed by another spirited cultivator. I have gradually, by the joint operation of two-horse ploughs and single-horse carts, reduced my number to *eight* horses. . . . Let farmers take the two-horse plough as a first, and the single-horse cart as a second step, and I have no hesitation in asserting that they will find themselves gradually, as they are able to master the working of the system, able to perform their labour, as I have experienced, with something approaching to half the number of horses that they now use, and with at least equal facility and comfort.”

This is a strong statement from ten years' experience, supported by calculations for which I must refer to Mr. Hannam's own paper,* and founded on the practice of the north of England—that one half of the purchase-money of horses, their wear and tear, their food, the bills for shoeing them, forming together a large part of the outgoings upon a farm, may be saved by the use of two-horse ploughs and one-horse carts. Now I would not advise a farmer even on these grounds to part with his waggons, because further

* Journal, vol. ii. p. 73. On the Reduction of Horse Labour by Single-Horse Carts. By H. Hannam.

inquiry is needed ; but I do think this question of one-horse carts well deserves that further inquiry, and ought not to be put aside : and I will avow, though living in a country of waggons, that, from what I have seen of one-horse carts, I believe these heavy waggons are doomed. One merit of the carts is their readiness in service. On a large farm near Wantage, Mr. W. Edmunds has adopted them ; and last year I witnessed them accidentally carrying barley : it was done most briskly by a man loading on each side, and one on the cart. The time occupied to load a cart high, and tie it by two ropes thrown over from each hind corner (which was done instantaneously), was five minutes by the watch, and the succeeding driver standing in his cart trotted up in his turn, keeping his time regularly, though the field was a hilly one. Carts certainly offer an important saving to a young man entering upon business. For Mr. Hannam says that, where waggons are used, there “ would be required, on a farm of 400 acres, six dung-carts, at 16*l.* ; two Dutch (mould) carts, at 10*l.* ; one marketing-cart, at 16*l.* ; and five waggons, at 35*l.* : total, 295*l.*” On the other hand, Mr. Hannam uses skeleton harvest-carts ; but, elegant as they are, they are not necessary. His own or any other light cart, fitted with rails and ladders, answers, I find, the same purpose ; and eight of these carts, at 16*l.* each, would amount to 128*l.* only ; so that here would be a saving of capital to the amount of one half. Leaving this subject, however, to the consideration of farmers, I must return for a moment to ploughing.

As to the modes of ploughing, it is not to be expected that much should have been brought to light in four years : but I may mention one point for which northern farmers have sometimes blamed those of the south—I mean shallow ploughing. On our trial-ground at Liverpool a southern farmer observed to me that the furrow prescribed (6 inches) was too deep, and immediately afterwards a northern farmer found fault with it as being too shallow. I have already detailed the practice of my own neighbours in ploughing light barren soils very shallow indeed.* Where they have ploughed sands deep even for turnips, in trying the Scotch practice, it has decidedly failed. Firmness is, I believe, quite as important for loose land as looseness for land which is over close. On some very loose land of my own I have seen the most remarkable improvement produced on a turnip-crop, for which tightness of soil is least requisite, by the passage of waggons in a previous year, and by the trampling of horses where a rick had been built. For a wheat-crop firmness, as all farmers know, is indispensable. Firmness, however, is not a positive but a relative

* Journal, vol. ii. p. 400. On the Practice of Farmers in cultivating Peaty Land.

term—relative to the soil, to the crop, and also to the climate. In part of Norfolk, according to Loudon, “they plough with two or four horses very shallow, carefully preserving the hard basis formed by the sole of the plough, which is called the pan of the land; breaking this up is said to let down the riches into the hungry subsoil.” One of our members, Mr. A. Edmunds, who has long farmed 200 acres of peaty land in Gloucestershire, tells me that he always ploughed it shallow, and that for wheat he did not stir it at all, but skimmed it only with a breast-plough. The summers there are probably hotter than in Lincolnshire, where peat is ploughed deeper. Near Coblentz, on the Rhine, where the summers are very burning, it is stated that the farmers only scratch the ground with a one-horse plough, because they find deeper ploughing injurious. I dwell on this point the more because high authorities in Scotland unite in recommending not only deep ploughing but trench-ploughing, that is with one plough following another in the same furrow, and throwing up the subsoil on the surface from the depth of a foot. This may be useful where the surface is light and the subsoil is a good clay, and it may be less dangerous to make the ground so hollow where rain falls constantly, and the land is seldom very dry; but, apart from the looseness produced, I should think that, as Mr. Denison observes, “in very few cases is the soil underneath more fitted for vegetation than that of the surface;”^{*} and I believe such an operation would be destructive on many of our southern farms.

The use of the plough may be sometimes even dispensed with altogether, by means of a class of implements on wheels, with teeth or tines that tear up the land. One of them is Biddell’s scarifier, which I believe to be a good working tool, because I see many farmers purchase it, and because one of my own I constantly find has been borrowed by my neighbours. A Suffolk farmer states † that “by the use of this implement he can equally well cultivate his farm with 12 per cent. less of horses.” Lord Ducie’s cultivator is also well spoken of, and our Bristol judges commend another by Messrs. Cottam. They likewise speak highly of a Warwickshire plough with slicers behind, which pulverise the soil like a harrow. If this simple contrivance of Mr. Mason’s should answer, it will be a remarkable discovery; but time and use must show its merits or its defects, and the soils to which it can be applied.

The land being worked, we may proceed to the crop. The sower, with his accurate hand and eye, is now seldom seen; but I am unable to detail the various modes of spreading the seed

^{*} Journal, ii. p. 32.

Ibid., vol. i. p. 348. Account of the use of Biddell’s Scarifier.

which have taken his place. The large drill is generally used for corn in the south, and the intervals between the rows of young corn enable the hoer to keep the land clean. As every seed, too, is covered with earth, less corn is required for the purpose. In Suffolk wheat is dibbled in by the hand, and a still further saving of seed is effected, one bushel being sufficient, instead of two or of three. This seems a strangely tedious process; but some of us, who may look on it as unworthy of a large farm, probably set our beans by hand, and should blame the Scotch farmer,* who sows broadcast 4 bushels per acre, while we find 1 bushel enough for that crop. Even corn, I believe, is but little drilled in Scotland. Should Mr. Rham be able to bring his dibbling-machine to perfection, he will have the satisfaction of saving the country one bushel per acre of wheat. I should mention that there is a question on the advantages of thick and thin sowing. Lord Western strongly advocates liberal use of seed, but I am unable to bring forward any facts on this point.

Great hopes have been entertained that by attention to the selection of seed, we might be able to increase the yield of our wheat, and many new varieties have been from time to time advertised, with favourable testimony as to their produce. Farmers, however, rightly view with mistrust very long, loose heads of corn and a great bulk of straw, having found such wheat liable to be laid, and subject to mildew, a disease which appears to arise whenever the vegetation of the plant, either from its own habit or from the manure applied to it, surpasses the strength of the soil. This I believe to be an important law of agriculture. Such long, loose heads of corn are often found to contain very little and very thin grain; or where the grain is large, the millers will not purchase it, because the bran is too thick. Our Society has offered prizes for the best specimens of seed-wheat, to be adjudged after trial by appointed judges; but as yet we have had no award, because the wheats selected at Oxford were mixed in the sack, and the Cambridge prize-wheats were not found to excel those against which they were tried. There is a doubt even about the principle of our selection, because, though the prize is for seed-wheat, our judges can only tell us which are the best samples of corn; but many farmers say that the plumpest sample is not the best seed;† that plump corn is most liable to rot in the ground in wet weather: they certainly do not use inferior wheat as seed from mere economy; for sometimes lean wheat is sold as seed at a higher price than other corn which is better for

* Professor Lowe's *Practical Agriculture*, p. 274.

† Sprengel I find also states that the best wheat contains too much gluten for seed—the gluten converting the starch into vinegar instead of sugar which is the food of the young sprout.

grinding. Still I believe that we have done good already by directing attention to old as well as new sorts of prolific wheat. It is impossible that so great a difference of yield should be found as 4 bushels an acre in many trials, and that some wheats should not give more than others, were it only half-a-bushel, in a regular course of farming; and though half-a-bushel be little, I need scarcely remind our members that in all calculations for general improvement of farming our multiplier for these small numbers is millions. I believe, however, that a greater increase than this may be hoped for, especially upon good land, for it is on good land, as far as I can ascertain, that the different qualities of wheat show themselves most; which might be expected, and is another instance of the principle, that soil will not bear to be forced beyond given limits. A familiar instance of this principle is the growth of white wheat, which, although more valuable than the red, has been abandoned excepting upon superior soils. It has been often tried in the parish where I am writing, but the ear produced is of a dingy colour externally, the grain poor, and, what is remarkable, of a red colour. Amongst the good wheats which have come to my knowledge, I may mention the Red Marigold shown by Mr. Fisher Hobbs at our Oxford meeting, the Burwell, the Chidham, the Golden Drop, the Silver Drop, the Golden Swan, the Bellevue Talavera (but upon good land, for on a moderate soil I have seen this last wheat fail in several cases), Hunter's White, the Hopetoun, an excellent Scotch wheat, propagated by Mr. Shirreff (to whom we are also indebted for the Hopetoun oat), and a wheat not yet known, a seedling raised by Mr. Jonas, of Ickleton, in the county of Cambridge: but for more accurate information we must await the result of future trials.

No improvement has been made during the last four years in barley; but a new kind had been already widely adopted, and is regularly quoted in market reports, which proceeds from a single ear picked by the Rev. Mr. Chevalier, at Debenham, in 1819, and is now well known by his name. A new kind of oat, however, is mentioned in our present Journal, which is remarkable not for larger produce, but for early maturity. This property is hardly important in ordinary English farming, but those who have seen the oat-harvest tardily ended, as I did last year on the elevated moors of West Somerset in mid-November, will be aware of its value for such mountainous districts where the chill summers seldom ripen the crop, and a doubt is entertained whether it be worth while to raise corn at all. There are such tracts in Derbyshire, and must be many such, I imagine, in Wales. Cumberland and Westmoreland, with a considerable portion of Scotland, have the same bleak and rainy atmosphere. The farmers of those

districts, and it is to them I address myself, will value the account which Mr. Fisher* gives of the oat raised from a single ear by Mr. Dyock, near Aberdeen, in 1830. It ripens a fortnight or even three weeks earlier than other kinds, and is equally productive with potato-oats in the elevated situations to which it is fitted. Its use appears to have spread gradually in Scotland. Mr. Fisher tried this oat for the first time last year in Westmoreland. He sowed it side by side with the potato-oat, reaped the Dyock oat on the last day of August, the potato-oat on the 20th of September, and obtained the largest return from the Dyock oat, as well as the heaviest sample. If this oat should maintain its character, a greater boon could not be given to the mountainous parts of Great Britain, since it would remedy at once for their staple crop the main difficulty of their farms.

But if we have not learned much that is new as yet respecting white crops, the information we have received upon green crops has made amends to us; nor is there any more interesting branch of farming. It is well known that the stock which furnished our forefathers with meat were fattened on the rich grass lands, but that, by a great revolution in farming, the light arable soils now chiefly supply the country with animal food. In the four-course rotation, consisting of Barley, Clover, Wheat, and Turnips, successively, while the wheat gives us bread, and the barley beer, a great part of the clover and all the turnips are converted into mutton, or sometimes into beef. But there is another ground for inquiry into green crops. It is commonly said that the farmers of the south of England are greatly inferior to those of the north, and the charge is hardly denied; yet I do not think that in the South we are at all backward in the management of our corn; on the contrary, I am told that our corn-fields are more free from weeds: our grass lands have also a decided superiority. It is our turnip-fields, with poor roots and large patches of bare ground, that offend the sight of those who are accustomed to the neat and vigorous aspect of ridges crowned with close-set heavy bulbs, in northern husbandry. A keen controversy has been carried on for a long time, chiefly in the "*Farmer's Magazine*," by practical farmers on this very subject, and has been called "*The Turnip Question*." The chief point on which it turned was, the weight of turnips that could be grown on an acre of land—the northern farmers asserting high weights, the southern denying them. Having attentively read the arguments, I will state what appears to me to be the result.† It is clear, I think, that the northern

* Journal, present Number, Mr. Fisher on the Dyock Oat.

† The relative expense of raising swedes in the north and south has never been fairly compared. In the north it is not uncommon to manure very heavily for swedes, and plough it in the ridges, and also to drill bones

crops do greatly exceed those of the south. Five-and-twenty tons to the acre of Swedish turnips are not an unusual yield in Scotland with ordinary good farming. Here the best crop I have grown with a heavy dressing did not exceed sixteen tons; one neighbour I believe has reached twenty. But in Lancashire prizes have been given during the last ten years by two district societies. The average weight of the prize-crops of swedes has been thirty tons: such a crop has never been seen in the part of the country where I am writing. To what, then, is their superiority owing? Undoubtedly to the ridge system, which has been so admirably described by Mr. Grey* of Dilston, in his account of Northumberland farming. In the first place, the dung being in the centre of the ridge immediately under the seed, the young plant is forced up more rapidly, and is sooner safe from the fly, which so often destroys the whole crop at its birth. In the next place, it is a great advantage that the horse-hoe can be used, instead of the tedious hand-hoe. Lastly, there is no doubt that the plant placed immediately over the dung attains a much greater bulk. Hence arise the fine turnip-crops of the north; and southern farmers are often blamed for not following this example; but wrongly, as I now see, for having endeavoured, during many years, to introduce the ridge-system into my own neighbourhood, I must admit that on some soils so far south it does not answer. Nor ought we to be surprised that it does not; for one object doubtless of the ridge-system is, by raising the turnip above the level of the soil, to free it from excessive wet; and this is a great gain in those northern and western parts of the country, Scotland, and even Lancashire, where the summers are constantly wet. But in many parts of the south we have to fear not wet, but dry springs and summers, at least upon turnip-lands; and it is not unusual that six weeks together should pass without rain. What is advantageous, therefore, in Scotland, may be hurtful here; and on this point I cannot do better than state the opinion of one of our members, Mr. Brooks of Hatford, near Faringdon, a practical farmer, which ought to have the more weight, because, having tried the ridge-system for many years, he has retained it upon one part of his farm, and abandoned it upon the other. It is upon adhesive land that he has found it fail, and, in his opinion, from two reasons:—When the ground is thrown over the dung by the plough, the small clods which such land almost always contains fall exactly into the centre; that is, in the

or other expensive artificial manures with the seed on the top of the ridge, the whole amounting to from 12*l.* to 15*l.* per acre; in the south a fair coat of dung, at less than half that cost, is the usual practice, while in many cases great crops of swedes are raised at a less charge than 2*l.* per acre for manure.—GEO. KIMBERLEY.

* See Mr. Grey on Northumberland Farming, *Journal*, vol. ii. p. 151.

line where the seed is to be sown, and form a bad seed-bed. Again, if dry weather follow, moderate showers do not penetrate the hardened surface of the ridges upon cohesive land. Upon a light sandy soil, on the other hand, Mr. Brooks finds ridging answer, and perseveres in it with success. There is indeed an advantage in ridging, where it is practicable, which I have not seen adverted to, but which I believe to be real. It is common to see on a field of green corn that the blade grows stronger in a line along the crown of each land, in consequence of the double portion of surface-mould collected by the plough, where the two slices of earth are lapped over each other in ploughing; now a turnip set on a ridge has this very advantage of a double foundation of the best mould. Still in the south of England on some soils we must give up the hope of establishing the ridge-system; but it does not follow that we are to renounce all endeavour at improving our turnip-crop. Even flat-drilling, I am told, has great advantages over broadcast sowing of turnips, for although dung cannot be placed immediately under the rows, bones and other artificial manures can. On one farm in Oxfordshire 1600 bushels of bones are drilled every year in this way. There is, besides, a much greater certainty of a crop, because the drill deposits all the seed at the proper depth, and thus the unseemly blanks in our turnip-fields may be prevented. Another great disadvantage in the broadcast system is the expense of hoeing them twice, or even three times, by the hand, which costs 10s. or even 14s. per acre. I do not know any good horse-hoe for flat-drilled turnips; but at Holkham, where mangold-wurzel is sown in this manner, an implement is used which hoes three rows at once, being drawn by two horses abreast. A good horse-hoe for flat-drilled turnips is, I believe, one of the most useful machines that could be invented, or if there be a good one already in use, though confined to its own district, that could be made known.

But when we have done all, applying to our turnips or swedes as much manure as the northern farmers, I doubt if it be possible for us to obtain in the south crops generally equal to theirs, for a reason to which I must now advert. In the north the swede and white turnip are each sown nearly a month earlier than in the south. Hence they have a longer time for their growth. For many years I have seen repeated attempts made here to follow this Scotch practice, and they have all signally failed; for as soon as warm weather comes, white filmy spots appear on the leaves of the turnip, which soon creep over its whole surface. This is mildew, and at once arrests the growth of the plant, rendering the root hard and stringy. In a bad case of mildew I have seen a large field of these early swedes struck in July, and filling the air with a most offensive odour. Last year, if ever,

early sowing of swedes might have answered in the South of England. At the time of our Meeting in 1841 there were beautiful crops of swedes near Liverpool, of which the leaves already met, and in that rainy region were, no doubt, perfectly safe. Here I found a last attempt which had been made at early sowing of swedes by Mr. Brooks, and I watched them with much anxiety. During the six chilly wet weeks which followed, they went on perfectly well. But no sooner did the sun shine forth in September, than after four days the white taint appeared, and the plants grew no more. I do not mean that nowhere in the south turnips can be planted early; for on the top of the chalk hills I know that they can; and it is well worth observing how very slight an elevation affects the climate, and consequently the growth of crops. On the Cotswold hills, which are of no great height, Lord Ducie, who has occupied a farm there, doubts if it be worth while to grow wheat. But generally in the south, I do not believe we can sow swedes or turnips as early as in the north; nor have we moisture enough for carrying them forward; consequently, though we ought to manure them more highly than we do, we cannot fairly be blamed, as we are sometimes blamed, for not raising crops equal to those of the north. Still many of us might grow much better turnips than we now do; and it is one of the points to which we ought in the South to give our most earnest attention.

But if our southern climate be against us in the growth of turnips as well as of oats, there is a root which our warm summers favour as they do wheat; that root is Mangold-Wurzel or Beet. I state this on the high authority of Mr. Lowe, Professor of Agriculture at Edinburgh, who says:—

“Beet, however, requires a somewhat favourable climate. It is accordingly more cultivated in the southern than in the northern parts of this island. Although in Scotland very good crops are occasionally produced, the plant is not so well suited to cultivation there as the swedish and yellow turnips; while in the southern counties the beet is probably a more productive crop than the turnip. Thus also in France and the warm countries of Europe the turnips are not to be compared with the crops which are produced of beet.” *

Professor Lowe's opinion, that a heavier bulk of beet can be grown than of swedes, is confirmed by Mr. Hillyard, who has raised both for many years, and informs me that where he gets 25 tons to the acre of swedes he would expect 30 tons of beet. The question then arises, can the farmer apply the mangold as profitably as the swede? It is well known that the swede is not

* Lowe's Practical Agriculture, p. 334.

very good for ewes suckling in February; the turnip is better, but does not keep well until that time, unless it be small; so that many farmers sow very late turnips for their ewes, which stand the frost, indeed, but give a very small bulk. The mangold is known to be good for all animals giving milk. But it also appears, from a remarkable experiment of Lord Spencer's,* that this root is good for fattening also. The two beasts put up by him made even more progress when fed alternately upon mangold than upon turnips, and he considers the result to have been decisive. Mr. Hill-yard, however, has undertaken to renew the experiment with regard to horned cattle; and it might be desirable to try it respecting the fattening of sheep. Still enough is known to encourage the growth of mangold; and Mr. Miles has given† us some good rules for its cultivation. The only difficulty is in the sowing; because, unless the seeds are put in very shallow they will not grow. But the dibbling-wheel‡ removes this objection. After the young shoot is come up, all anxiety is at an end. It is attacked neither by fly, slug, nor wireworm. Unlike the swede, it can be sown early in April. It can be grown, too, on heavier lands than even the swede. The common long red beet exhausts the land rather more, in Mr. Miles's opinion, and requires rather a better soil; but the orange globe will flourish wherever the swede will succeed. I find in Count de Gourcy's Travels§ that Mr. Fisher Hobbs, who has grown beet for many years, and has tried twenty-eight kinds, regards the red and the yellow globes as the most productive varieties. It appears also certain that in our four-course system the turnip-crop returns too often. All the manure we bestow on the turnip does not produce such fine roots as were seen forty years since, when it was new to the land, and the site of a freshly grubbed hedge puts our best cultivation to shame.¶ For these reasons, and because the beets keep longer in spring than any turnip, I think they should be allowed a share of the root-fields on every farm to which they are suited. The merits of the four-course system are great, but a great defect too is its monotonous circle of wheat, turnips, barley, and clover.

* Journal, vol. ii. p. 200.

† Ibid., p. 298.

‡ It is stated that a double wheel answers still better. Journal, vol. iii. p. 164. A small frame with a short row of dibbles, held in the hand, may also be used.

§ A translation of this very interesting agricultural tour is now appearing in the "Farmer's Magazine."

¶ It is well known that all varieties of beet require to be stored before the setting in of severe frost. This is now frequently done with swedes also. They are either earthed up in the field, or carried home to the yard, where care should be taken that they have a free circulation of air. It is one of the advantages of this extending practice, that it affords a busy month of employment for women at a time when other labour is scarce.

There is another root, however, which promises also to break through that monotony, and has been made known in England since the foundation of our Society, though it has been common for two centuries in Flanders and Germany. I mean the white carrot, of whose produce such surprising accounts have been published. It has been stated to give 30 tons to the acre, each ton selling in some neighbourhoods at 2*l.*, or double the value of swedes. Lord Ducie grows it regularly at Whitfield-farm, and obtains 24 tons to the acre: the green tops alone, which may be given to sheep when the root is taken up, are said by Mr. Harris to be equal to a second crop of clover. The only difficulty in its cultivation is the slow growth of the young plant, which can scarcely be distinguished from weeds, unless by women cleaning them on their knees; but this may be obviated by drilling the carrot; and I am told it may be grown on ridges, and therefore horse-hoed. They will thrive on rather strong land, though light warm land is most natural to them. Subsoiling is almost indispensable, which may be done, however, with a common plough. As this root seems likely at last to take a permanent place in English farming, and as it may be interesting to know in future times how it was introduced, which has been often questioned with regard to the turnip, I may put on the records of our Society, that it was brought over in 1835 by Mr. Rham of Winkfield. There is another carrot, the early horn, of which Lord Ducie obtained 16 tons to the acre—no trifling yield—and which, by its almost globular shape, appears suited to very shallow soils.

With regard to the use of the carrot, it is known to be good for horses, though too much of it should not be given them before spring, as it is supposed to weaken their eyes in winter. It is also excellent for milch cows. All stock, indeed, is so fond of the carrot as to produce a difficulty in its use, for it makes them refuse other roots; but it may be mixed with them after steaming. It appeared, from the account which Colonel Le Couteur has given us of the great bulk of parsneps raised in Jersey, that we might have had to add this root also to our field-crops; but he has since found the white carrot yet more productive, and the tapering growth of the parsnep makes it very difficult to draw from the ground.* I have therefore only to add the mangold-wurzel potato, which is very coarse, but extremely bulky, and is said to be the only potato that should be given to pigs without previously boiling. Of its merits, however, I know nothing positive.

Such is the information we have received on those roots by which our stock are sustained in winter; and I cannot but look back

* Parsneps have one advantage over carrots, that hares and rabbits seem not to touch them.—BRAYBROOKE.

to the former history of farming on this point. The castles of the old barons were victualled at Michaelmas with salt beeves and sheep, because there was little hay for their winter keep. Afterwards more hay was made, and fresh meat was obtained through the year. When our population exceeded the extent of our meadows, the common turnip was introduced : but as this does not well resist frost, it would last only till February. Then came the swede, which carries us on till the end of March. Another class of summer-food, clover, had been also introduced, but would not be ready so soon : vetches therefore were sown in autumn, to be fed off in spring. But there is still an interval to be filled—for vetches do not come in as soon as swedes are ended. Mangold-wurzel indeed will carry us through this space of time ; but it appears also that, while winter-feed may be prolonged, spring-feed may be hastened by growing an early variety of vetches ; and Mr. Williams, a farmer of Ilsley, informs us that last year he had vetches 3 feet high in the beginning of May, on a backward soil in a high situation. An account is given of this vetch in another part of the present number. Its importance will be seen at once by all flockmasters ; if it should stand the trial, the circle of artificial food will be completed throughout the year, and a wonderful triumph, I must say, be secured by the farmer's skill over the seasons. Early rye, indeed, has long been used for the same purpose, though some farmers do not approve of it ; for while young it gives little food, and it shoots up rapidly to a harsh stalk which stock do not relish. Clover of course is the mainstay during summer ; but it is acknowledged that generally land will not bear its recurrence well every four years, though we have not yet found a substitute. The Italian rye-grass is evidently an acquisition, as it gives not only a greater bulk than the common rye-grass, but is also preferred by sheep. This is a new plant ; but in the present Journal we have a strong recommendation of an old one, Lucerne, which is the more interesting because Mr. Rodwell brought it before the Board of Agriculture in 1811, and speaks of it with unabated confidence now in 1842. It requires, however, I believe, some depth of soil, and perhaps a favourable climate. Rape, the green crop of the fens, is evidently at home upon poor peaty land, pared and burnt, or dressed with peat-ashes ; for such land has a tendency to produce leaves rather than roots ; and ashes throw up the rape so strongly, that a flock of sheep is hidden among the stems when at feed in the pen. Sainfoin, on the other hand, is known to prefer a soil full of natural lime. There are many new plants recommended for summer soiling—the Bokhara clover, the Siberian vetch, the Siberian bear's-claw—all three of gigantic growth ; but of their merits we know nothing as yet, nor

of Spurry or of Maize (Indian corn), which was recommended at the Doberan meeting of German farmers to be fed off green.

From green crops we are naturally led to the stock which is fed on them; but so much has been done during forty years by the Smithfield Club for our cattle, that little can be expected in four years from our Society beyond a wider exhibition of the superiority of English breeds. As those, however, who have not studied the subject undervalue sometimes the shows of fat cattle, because the individual animals are too fat for consumption, I think it may be useful to prove what the Smithfield Club has really done. Grazing animals in a wild state, according to Dr. Liebig, will hardly become fat at all. Deer in a park, for the same reason, are not killed before they are six or seven years old; and many may even now remember that mutton was once eaten when five years old. But by selection of individuals in breeding it was found that this time might be shortened. First, the Leicesters—then our larger long-woolled sheep, the Cotswolds—and last, the short-wools, or Southdowns—have been cultivated on this great principle of early maturity; and the Southdowns, as well as the others, have been brought to market as mutton in four, three, two, and lately on some farms at one year of age: so that, to say nothing of root-crops having been multiplied four times in weight, the same amount of green food which formerly gave us a sheep only every fifth year is able to produce us now a sheep every year—that is, five sheep for one. A deduction must of course be made for the breeding ewes. It is but common justice to the Smithfield Club to show this vast good which they have done to the country. There is also a Scotch breed of improved sheep, the Cheviot, which I believe would be better suited than our Southdowns for the mountainous parts of Southern England. The same principle has been applied to horned cattle, of which we have also three established breeds—the Short-horns, the Herefords, and the beautiful Devons. Though early maturity has not been carried so far with them, no breed out of Great Britain can compare with them in aptitude to fatten. It is said, indeed, that better milkers may be found than even the short-horns; and this may be the case: but milk alone cannot be made the test of cattle even for a dairy farm, because the cows which are necessarily discarded each year, for age or barrenness, ought to be suited for fattening. In cattle, too, a Scotch breed, the Ayrshire, may stand by the side of our own, as it appears to unite in a high degree the two requisites of milking and grazing, both upon moderate land; but whether it be suited to our rich southern meadows must be very doubtful.

All these breeds are now fatted chiefly, not on grazing pastures, but on arable ground. The origin of this practice was no doubt

the production of meat for an increased population; it is continued and extended, not from a view to profit in the sale of the meat, but for the production of dung, and the consequent increase of the corn-crop. It is well known to farmers, though not to others, that the dung of an ox fattened with corn or oil-cake is far more valuable than that of a cow kept in merely ordinary condition—perhaps worth twice as much. This principle is the great distinction of English agriculture, and constitutes what is called high farming. It is worked out in different ways.

Every autumn horned cattle move across England, from Devonshire, Herefordshire, parts of Yorkshire, and Scotland, to the eastern coast, where they are fattened. I do not know why this practice should be confined to that side of the country; but though it may be known elsewhere to individual farmers, all the counties in which stall-feeding seems to be established lie to the east—Essex, Suffolk, Norfolk, Cambridgeshire, Lincolnshire, Yorkshire, Northumberland, and in Scotland the Lothians. There is some variety, however, in the mode. The more common method, I believe, is to tie up the beasts in stalls in close houses. In Northumberland, Mr. Grey of Dilston informs me that this plan is given up, and that the cattle are kept loose (eight or nine together) in small yards, with an open shed on one side: he gives as the reason of this change, that they appear to be more healthy when so treated; that they turn the litter more regularly into manure, do not lose their hair, and, their joints not being stiffened, are better able to travel to market. In Lincolnshire, again, many good farmers find it answer not to fatten beasts at all, but to keep young stock in straw-yards; not, however, upon straw only, as in the old system of low farming, but pushing them forward with oil-cake: for this is one great merit of improved farming, that whereas, by the old practice, the animals which serve for our food were kept often on the brink of starvation for several years—by the new one they are maintained in an improving state from their birth; and so their comfort, as long as they live, coincides with our profit. Such is the high farming of the eastern side of England—there so well known that it may appear superfluous to have described it at all; but in the counties with which I am more conversant—Oxfordshire, Wiltshire, Hampshire, and Berkshire—a feeding-house full of oxen on an arable farm is almost, if not quite, unknown; yet here, too, we have high feeding, which is high farming, but it is the high feeding of sheep penned on the turnip-field, receiving hay, peas, barley, oats, or oil-cake, with their turnips sliced for them in troughs (nor is there a better mark of good farming for the traveller than a turnip-slicer in the fold), and brought to market sometimes at the age of one year. This is excellent farming: and I have been

repeatedly told by farmers that where two flocks have been kept in one field—one fed with corn, the other not—the difference may be distinctly seen along the line where the hurdles had stood in the following crop of barley, marking the efficacy of high feeding.* Still, good as the system is, it has this disadvantage in comparison with the feeding of beasts, that the straw grown on the farm is not made into strong dung, but is merely trampled in large yards, from which it comes out very little changed even in its appearance.

But Mr. Childers has brought forward interesting experiments, which show that sheep, as well as oxen, thrive much better for warmth and shelter. He states that “eighty Leicester sheep, on the bare field, consumed about 50 basketfuls of cut turnips per day, besides oil-cake.” “On being brought into the shed,” he proceeds, “to my surprise, they were immediately only able to consume 30 baskets, and before a month had elapsed the quantity had decreased to 25 baskets; thus economising one-half the turnips: they also ate less oil-cake. I found, nevertheless, that their increase was as rapid this year as it was the year before.”† In the year before, the sheep in the shed had gained one-third more than those in the field: so that here was a saving of one-half of the turnips, with a gain of one-third of meat. Now this result agrees precisely with the most recent discoveries of Dr. Liebig, who has shown that the natural heat of the body is kept up by the use of food, and that the greater the cold the larger must be the consumption of food; and he instances the Samoyedes, who eat ten pounds of meat daily. “Warm clothing,” he adds, “is a substitute for excess of food.” Now I do not say that we are at once to house all our sheep: because, apart from the labour of carting home the turnips and carrying out the dung, the treading of the sheep is almost indispensable on light soils for rendering them firm. But I do think Mr. Childers’s discovery most important, and well worth the serious consideration of sheep-farmers; and that, in time, it may become the foundation of a change of practice—that the fatting sheep, for instance, may be housed, and the breeding ewes be left on the land, or the fatting sheep be housed by night in winter, or, as Mr. Childers suggests, during the heat of the sun in September. It may be said, indeed, why house sheep in heat, if cold is to be guarded against? Partly because heat disagrees with them, as is shown by their panting beneath the sun and seeking the shade, and partly because one advantage of housing them is the saving of dung: for many farmers suspect that there

* In one instance, where a very dry summer followed, the advantage was in favour of the less highly dressed land; a strong instance of the power of dung to injure barley in a dry summer upon burning land.

† On Shed-feeding, by Mr. Childers—*Journal*, i., pp. 169 and 407.

is sometimes a great loss of manure when made by sheep on the land. In dry weather, when the ground is hard, either from heat or frost, a portion of it evaporates rapidly; in wet weather, on light lands, I doubt if it be not sometimes washed downwards below the reach of the following crop. The change, however, would be so great that it would be unwise to make it at once; and, indeed, we require some further experience of its effects on the health of the sheep.*

There is another principle in Mr. Childers's concise paper, scarcely, if at all, less important than that of shed-feeding, which I confess had escaped me altogether, until it was ably pointed out by the Rev. Mr. Thorp, in a paper† read by him before "The Yorkshire Society." That principle is rapid feeding. The usual course, I believe, in feeding sheep, is to keep them about four months upon turnips, increasing the additional food, such as corn and cake, towards the end of the period; but Mr. Childers proposes to feed them to the utmost from the very first. "I think," he says, "the greatest profit would be made by shedding them for about ten weeks. By giving them cake and a little crushed barley I think you may gain from 33 to 40 lbs. per head in that time; their increase in value during that time cannot be less than 15s. to 20s. per head; and in this way you may feed off two or three lots during the winter. In ten weeks they consume half a ton of turnips each. Thus, with artificial food, an acre of 30 tons will feed no less than 60 sheep. The artificial food will cost from 6d. to 1s. each per week."

This would not be exactly a saving of food, as in shed-feeding, but a substitution of other and expensive food for so many turnips, and the further question must be asked whether this substitution will pay. Assuming Mr. Childers's figures to be correct, that 15s. are added to the value of the sheep, and that the additional food costs about 9d. a week for ten weeks, there would be left 7s. 6d. for the half ton of turnips, which would be enough. The outlay on extra food is large; but then the return would take place in a shorter period, namely, ten weeks, when the money would come back, and a fresh purchase be made. If the system would pay, it is self-evident that a vast increase of the best manure, the whole object of all feeding, would be obtained; and though it is somewhat startling to hear of 60 sheep being fattened on a single acre of turnips, still it would be worth doing, and ought to be done for the sake of the public, if it can

* Mr. Thompson, of Kirby, has just informed me that shearlings bear shedding better than lambs, and that one farmer who tried shedding last year had considerable loss by purging; he therefore recommends that the back of the shed should be made of open wattle, or that moveable sheds should be used in the field.

† On the Feeding of Sheep—Supplement of this Number.

be done without loss. This principle of rapid feeding which Mr. Childers has brought forward seems well deserving inquiry; since if it be practicable it must greatly increase our manure, and consequently our crops, according to the bountiful provision of nature, that the more meat we raise on our land, the more corn we are enabled to grow; and that thus, again, having obtained more corn, the more stock in return we are able to feed.

This brings me to the most difficult subject in agriculture, which I have therefore reserved for the last. I mean manure, on which it may be said that we have learnt a great deal in the last four years, but know nothing; for we have learnt many of the chemical principles on which manures act, but we do not yet know how to apply those principles to the daily work of the farm. It is now established that the most important ingredient of farmyard dung is ammonia—the same substance as common smelling-salts—known to escape very readily in the air; and there is a growing opinion that a great deal of it does so escape from our farmyards, which is doubtless the case; though I am not sure whether the alarm on the subject be not somewhat exaggerated. For ammonia arises chiefly from the urine of the cattle, but it does not form itself until after some days; and by that time in a well-littered yard it has sunk from the surface, and has been trampled down fast, so that it can less easily evaporate. Whilst it is forming itself, too, the straw begins to decay; and it is the opinion of Sprengel that an acid called the humic acid, formed from the decaying litter, has the property of combining with the ammonia, and removing its volatile property.* This must be doubtful, of course, and various means of fixing the ammonia have been proposed. Sulphuric acid is one, either in the shape of gypsum, which has been found not to answer, or in that of green vitriol, or as a pure acid; but these are at present only suggestions. We have been also strongly urged to imitate a foreign practice of using liquid manure, spread from a water-cart; but this I believe to be a very doubtful innovation. For if the urine be collected separately, it is the opinion of Sprengel† that a still

* Where peat can be obtained, it assists in fixing the ammonia when mixed with the dung, according to Lord Meadowbank's process.—See *Journal*, i., p. 147.—Mr. Dixon on Compost Heaps.

† Dr. Sprengel, after describing the various methods of employing liquid manure, uses these strong words:—"Whoever is obliged for want of straw to collect the urine separately—whoever, if he be compelled to do this, mixes no water with it, or who fails also to employ some neutralising substance to combine with the ammonia which is produced in so great a degree during the summer—suffers a loss of manure which exceeds all belief. It is indeed only a gaseous substance, and not a solid material visible to the eye, which thus escapes and is lost; but for all that it is of greater importance to the plants than any other portion of the droppings."

greater escape of ammonia takes place, unless some substance, which is not yet ascertained, be added to fix it, or it be largely diluted with water, which occasions great labour in its application. This last objection lies also against the other form of liquid manure, the runnings from the yard collected in a tank; for after heavy rains they sometimes do not contain above two per cent. of salts, and are then not worth the labour of carriage. It appears that this foreign practice has arisen from two causes: one, the want of litter, and where the same cause exists, as on some of our dairy-farms, the method might be well introduced; the other motive is the desire in Flanders of applying a liquid top-dressing in May to the corn growing on sandy land, or else to a second crop, such as carrots sown amongst beans: but this last case does not arise in England. Some loss, however, must arise by the runnings from every farm-yard; for whether the ammonia be fixed or escape in the air, there is no doubt it is still soluble and runs away in the water. One remedy is, to prevent the rain from flowing down the surrounding roofs into the yard, by placing gutters under the eaves. Perhaps another would be what I have seen in an old-fashioned yard, a hollow space, like the basin of a dry pond, three or four feet deep, with a drain near the top that prevents it from overflowing. This hollow I was about to do away with as unsightly; but when filled as it now is with couch-grass—leaves or stubble would certainly have a better appearance—it seems likely to answer the purpose of detaining valuable salts that would otherwise run away. It is also supposed that great waste arises when dung is spread on a field; and this theory has been carried so far that a serious charge has been brought in a daily publication against the farmers of the Vale of Aylesbury for dressing their meadows, not at a wrong season, but for dressing them with dung at all, as if the whole essence of the dung must be evaporated, though the farmers had not yet found out their mistake. Some waste, I suppose, takes place, for which on meadows there is of course no remedy, but perhaps not so great as is imagined. Mr. Handley informs me that he has observed for years a common field, on part of which, occupied by cottagers, the dung was sometimes allowed to lie spread for many weeks, while on the remainder it was ploughed in at once, but he never could detect any difference in the succeeding crop. Possibly after the dung has fermented, a great part of the ammonia is reduced, as Sprengel supposes, to a fixed state. If so, we must hesitate to adopt what many have recommended and practised, the ploughing in of dung in a fresh state. After all, if the yard be well littered and the dunghills be covered with earth, I doubt whether, excepting on grass farms where the tank may be necessary from the want of straw, the present manage-

ment of dung can be greatly improved, though in many districts the quality certainly may be.

But besides farm-yard dung, we have an infinite variety of artificial manures or hand-tillages; indeed, it may be said that there is no refuse of any trade, provided it be animal or vegetable, except tanner's bark, which is not or might not be used for this purpose. It would be useless to enumerate all, as they are well known, and the supply of many is very limited. The two principal articles are Bones and Rape-dust, the former suited for light land, and used chiefly for turnips. It is remarkable how very local is the use of both these manures; that of bones, indeed, is spreading, but rape-dust is not much known in the south; and certainly where artificial manures are new, there is some unwillingness to lay out money upon them, though dung perhaps is bought at 5s. the cart-load, and carted with great labour at a long distance. When bones were first used, it was thought that unboiled bones must be better than those from which the animal oil had been extracted; but the reverse appears now to be true—not that animal oil is useless, but that it sheathes probably the bone, and checks its action upon the plant. There remains, however, in the bone another animal compound, gelatine, or the matter of jelly; but Sprengel states he has repeatedly found that bones act as strongly after they have been burnt,* when the jelly of course is removed; and this is well worth remarking, because the body of the bone consists of phosphate of lime, evidently another powerful principle, which is found also abundantly in urine, and consequently in dung. But though the character of bones is established upon light land for turnips, even this manure fails on some soils of that quality. I have some light land where it acts very feebly, some where it does not act at all, and on which many hundred bushels of bones have been quite thrown away. There is also some light land near Baldock, on which bones have been proved to be useless. This shows that we cannot be too cautious in prescribing even the most approved remedies for the first time upon land.

Rape-dust appears to be established chiefly among the farmers of Nottinghamshire, Yorkshire, and Lincolnshire. As it is one of the few hand-tillages which can be applied to clay, and as some of our south-country clays are much in want of assistance, I may

* Since this was written I find that Mr. Hannam, of North Deighton, near Wetherby, has this year repeated the experiment with the same result. "In order to solve the question," he says, "we burnt in a pit a quarter of bones and drilled them with turnips (both swedes and white ones); and on two other patches we applied a quarter of unburnt bones from the same stock as the burnt ones were taken. The turnips are now growing, and, as far as can be determined, seem to thrive with the burnt bones as well, if not better, than with the unburnt."

mention that, according to an excellent prize-essay* by Mr. John Hannam, the best mode of using it is drilling with autumn-sown wheat at the rate of 4 or 5 cwt. to the acre, the price being about 7s. per cwt.

As another instance of the local prevalence of manures, woollen rags may be cited, which are the only hand-tillage familiarly known to farmers in my own neighbourhood. Mr. Hannam states "20,000 tons of rags are said to be used annually by the farmers of Kent, Sussex, Oxford, and Berkshire. The price is about 5*l.* per ton. They answer extremely well for hops and wheat. They are usually cut by a chopper into shreds, and applied by the hand at the rate of half a ton per acre." Six or seven cwt., I believe, is a fair dressing for wheat upon light land; on heavy land rags are not used here at all.

With regard to Nitrate of Soda, from which so much was once expected, there are the most undoubted proofs from numerous quarters of an enormous increase in the produce after its use; there are as undoubted instances of its utter failure: nor have we any clue to the mystery.† On the same land where it gave me 8 bushels of wheat one year, it gave barely 3 in the following; and having tried it largely at that time on four different farms, nowhere with success, I have given it up. Still there is evidently a principle of fertility in it which will some day be found out, and some farmers continue to use it, but in several cases it has produced mildew in wheat and barley by forcing the crop beyond the strength of the land. By the side of the nitrate I tried on several fields the sulphate of ammonia, extracted from gas-water, for the first time. It acted precisely as the nitrate of soda, darkening the colour of the plant, and lengthening the straw and the ear even more than the nitrate, but it certainly did not pay. Again we have the principle, and we must learn to combine it.

I can speak with more confidence of the last new manure, Guano, having used it on a small scale last year, and to the extent of 5 tons in the present season. There are two circumstances in its favour beforehand: one, that it is in fact dung, though of very ancient origin, still bird's dung, which is known to be the most powerful of all manures—the other, that it has experience in its favour, though a distant experience certainly,

* Any member who is desirous of trying rape-dust will find full information upon it in this prize-essay of the Wetherby Agricultural Society upon Rape and other Hand-tillages, published last month at Leeds.

† A full statement of all the recorded experiments on nitrate of soda is contained in Professor Johnston's 'Chemistry and Geology applied to Agriculture,' whose book is the most complete account of agricultural chemistry that we possess.

at the other side of the globe, in Peru—still an experience of 300 years. It appears to be best calculated for root-crops. On a light loam, where it has been used here this year for turnips at 3 cwt. to the acre, costing 45s., it has nearly equalled 20 loads of very good dung, and has beaten 20 bushels of bones costing 65s., as well as several other artificial manures beyond any comparison. Where it has been broadcast and harrowed in with late turnips, it has pushed them on well, while on two patches left without guano there is no plant at all. Last year, when drilled with the seed, it killed half the seed. This year, though mixed with sand, and drilled separately, with earth spread over it, some of the plants have perished; and two farmers have told me that, with the same precaution, though the seed grew, the plant also died when the root reached the guano. It is a curious fact that the same thing once happened to one of our members, Mr. Graburn, when he placed the ordinary allowance of rape-cake immediately under the seed. Drilled in with barley on a very poor sand, it has acted very decidedly; but I find it has only given me one quarter of barley, so that, unless it acts next year, it will not have paid back its cost.* It has failed as a top-dressing on corn and on clover. But having stated these cases of failure, I must say that guano seems an excellent manure for root-crops, if rightly applied,† and, as it is now sold at 12s. the cwt., a very cheap one; but I should be sorry if any of our members tried it largely in consequence on a different soil without success.

Quicklime, again, is so largely used on the west side of England, that it bears there the name of manure, to the exclusion sometimes, I am afraid, of dung; while on the other side of the country it is almost unknown. Whether lime could be adopted elsewhere, is a very interesting question, and what is its mode of operation. Sir H. Davy's theory, that it dissolves vegetable matter, is given up; in fact, it hardens vegetable fibre. Some persons think that it should be applied hot to the soil, founding their view upon chemical principles, but at present it seems better to follow practice; and where it has been mixed heretofore with five times its bulk of earth, and left so in heaps for some weeks before it is applied to the surface, it would be well to do so still. Indeed I am told farmers near Totnes, in Devonshire, have given a fair trial to fresh lime, and have found it act

* Mr. Pryme has found guano fail when drilled in with barley.

† I think that guano should either be sown broadcast (mixed with mould) and harrowed in rapidly before sowing the seed, if the crop is flat-drilled; or, when it is ridge-drilled, I have sown the guano broadcast upon the first ridges. When these are split, the guano is brought home to the roots of the plant as it stands on the second drill.

not at all better than when it is slacked.* Dr. Liebig has recently discovered that lime has the power of decomposing clay, and producing potash and soda, which are manuring principles: now if this be the mode in which lime acts, there could not be a better course than to mix lime with earth before it is thrown upon grass-land, and the old practice would agree with the true theory, as is often the case. Of all things we must guard against premature inferences from abstract science; but be the cause what it may, the effect of lime in sweetening sour pastures is wonderful throughout the districts where it is used, and it is well worth inquiry whether it could be applied in those districts where it is at present unknown.

We have then several substances more or less simple which produce the effect of dung. The mode of their action belongs not to the practice, but to the theory, of agriculture, into which I am not competent to enter; but as important discoveries have lately been made in that department, I will endeavour to state the modern German Theory as founded by Sprengel, and lately established by Dr. Liebig.

Plants consist in the main of several vegetable substances, which are, however, all composed of *four* kinds of air variously combined; these gases are named Oxygen, Hydrogen, Carbon, and Nitrogen. Dr. Liebig supposes that the two first are derived by the plant from water; the third, which is charcoal, from the air; and the fourth, nitrogen, which constitutes the most nutritious part of our food, from ammonia: which substance he has found not merely in the dung of animals, but in the water of rain, a new and remarkable fact. But there exists also in crops a considerable quantity of earthy matter; in every ton of oat-straw, for instance, nearly one cwt. of flint, whence, if a hayrick be burnt lumps of a substance like glass are often found in the ashes. These mineral substances vary in different plants as to quantity, but eight are generally to be found in their ashes, *four* of the eight being Acids, namely, that of flint, which is Silica; of bones, Phosphorus; of brimstone, Sulphuric acid; of common salt, Muriatic acid: and also *four* Alkalis, Potash, Soda, Lime, and Magnesia.† These, Dr. Liebig says, cannot of course be formed

* On the other hand, at Woburn, I have just met with a case in favour of recent lime. The soil was a light sand with a tendency to blackness at top: half a turnip-field had been dressed with fresh, and half with slacked lime, and there was a marked difference in favour of the fresh lime. As far as our knowledge goes, which is not far, lime appears to me to act wherever there is a natural tendency in the soil to cover itself with heath on waste places, and also wherever the soil is of a deep red, which colour indicates a peculiar salt of iron.

† A very small quantity of alumine, or the earth of clay, is also usually detected in the ashes of plants.

in the plant, but must be derived from the soil; and accordingly there they are generally to be found when the soil is examined by chemists, but in limited quantity, so that the soil may become exhausted of one or more of them. But further, all these eight mineral substances are to be found in farm-yard dung, besides ammonia, the source of nitrogen: hence the excellence of dung for all crops indifferently. Some crops, however, require more of one ingredient than of another: hence the good effect of bones upon turnips, which contain a great deal of phosphorus, and of gypsum or peat-ashes, which contain sulphate of lime, upon clover; of Epsom salts also, Dr. Liebig states, which contains magnesia, upon potatoes. Some soils, again, may contain so much of one of these eight minerals, that it may be useless to add any more. Thus gypsum is found to be useful in one part of a field and not in another, and bones are useless in Mecklenburg, where the fields are dressed with a marl full of phosphorus; or, on the other hand, a tract of country may be deficient altogether in some one of the eight ingredients which is necessary for all crops, as in lime: in such a district lime will be a standing manure. This is a very superficial view of the new theory of agriculture, which, though but a theory at present, certainly promises important results. In order to test it first, and, if it hold good, to apply it afterwards, two courses of inquiry are requisite—one, as Dr. Liebig informs me, a more minute examination of the ashes of plants, in which these mineral substances are found, and further a more accurate analysis of our various soils, in which last particular English science is sadly defective: for Dr. Liebig observes, “Davy has made several analyses of various fertile soils, and since his time numerous other analyses have been published, but they are all so superficial, and in most cases so inaccurate, that we possess no means of ascertaining the composition or nature of English arable land.” This reproach on our science ought certainly to be removed; and it is easy to see how varied a field of inquiry is opened by the new theory. At the same time, though it is a most promising theory, it would be premature to expect that for some years to come chemistry should be able to direct, or materially to benefit, actual husbandry. But though we have not yet seen the secret workings of nature, I believe that we are near the door, and that the veil will soon be raised. Any young chemist, who will take up the late brilliant discoveries of general principles and devote his life to patient research into the means of applying them, may hope to acquire an imperishable reputation; and it is evident, from the ardour with which chemists now embark in agricultural research, that they feel they are making progress. But we certainly have to

thank men of science generally for the readiness with which they have come forward: Dr. Buckland, Mr. Murchison, Sir H. Delabèche, have helped us in geology; Professor Henslow has given us a complete history of the diseases of wheat; Dr. Daubeny, as the Oxford professor of agriculture, might be said to belong to us. Mr. Johnston, of Durham, has contributed an excellent account of guano, in addition to his own valuable publications; and the Society has engaged Mr. Curtis to write for us a complete history of the insects which are injurious to crops.

Such are the principal facts which have come to our knowledge in the last four years. I ought to have spoken of machinery, but the shows in our implement-yards have spoken for themselves, and we have most able reports from our judges; yet I cannot but advert to two circumstances: one, that a manufacturer informs me his threshing-machines, which seven years ago only threshed 15 quarters of wheat in a day on an average, now thresh 25; the other, that, in accordance with a suggestion made in the first number of our Journal, travelling threshing-machines worked by steam were brought forward by two makers at Bristol, Messrs. Ransome, and Mr. Cambridge of Market Lavington, in Wiltshire. I may add that Mr. Howden and the Messrs. Tuxford of Boston have each constructed for travelling men similar machines, which are now commonly let for hire in the fens of Lincolnshire. The most gratifying discoveries, however, have been the discoveries of old practices unknown beyond their own districts. I am certain that four years ago no one knew how much good farming there was in the country. Now that these things are come to light, we may hope that they will not only be spoken of, but be practised more generally: that draining-tiles will be greatly cheapened, more drains be cut, more chalk be laid on the downs, the wolds, and the clays, marl on the sands, clay on the fens and peats, lime on the moors, many of which should be broken up; that old ploughs will be cast away, the number of horses reduced, good breeds of cattle extended, stock fattened where it has been hitherto starved (though this is now rare), root crops drilled and better dunged, new kinds of those crops cultivated, and artificial manures of ascertained usefulness purchased. It is the knowledge of these weapons which we actually have in our hands that may make us look back with satisfaction to the efforts we have already made, and forward, with cheerful confidence to the improvement of husbandry through the collective experience of our farmers.

Pusey, Oct. 7th, 1842.

ADDENDUM.

Having had the advantage of seeing in Bedfordshire, since these pages were written, practical examples of some of the points which I have ventured to bring before the Society, I am desirous of shortly mentioning them. On the estate of my friend Mr. Pym, at the Hazells, may be seen the admirable effect of *marling*. His neat and productive farm is a light yellow sand, which naturally was covered with heath, as may be seen on a small portion reserved for the beauty of its scenery, which strongly resembles a Highland glen, being not only covered with heath, but also with grey lichen, like the grey moss of trees,—a kind of vegetation which shows a great degree of sterility. The whole farm has been made fertile by means of a dark grey clay, which is full of lime, situated at the foot of the sandy hill, and the moderate dose of 60 cart-loads per acre is found to last at least 20 years. On this *sandy* farm both turnips and swedes were *ridge*-drilled, and looked remarkably well. In going from the Hazells to the town of Bedford I travelled for 10 miles across the valley of the Ouse. Here may be seen on almost every farm admirable crops of swedes, in fields of 40 or 50 acres, without a defective spot of bare earth. The soil is rather a *strong* loam, upon gravel not unlike the land near Salthill; and the swedes were *flat*-drilled, not upon ridges. At Bedford I had the pleasure of seeing the county ploughing-match. There were forty ploughs, all upon *wheels*, and, though the land was rather strong, all *two-horse ploughs*. Next morning I was permitted to go over the home-farm of the Duke of Bedford at Woburn. Here are two or three fields of very strong land, which had been *thorough-drained* and also subsoil-ploughed; which latter operation was thought to have rendered them much lighter to plough. The land, however, is not clay, but marl, a more crumbling substance than clay. But the arable farm in general, which contains 500 acres (besides 700 of permanent grass), is a sandy hill, resembling Mr. Pym's,—indeed a continuation of the same low range; and has been dressed with *marl* in the same manner. One of the fields had not only been covered with heath within a few years, but had been the common turbarry of the neighbourhood, so that the surface-soil had been carried off by the poor for fuel. The whole appeared now highly productive. I went over 180 acres of root-crops, and I do not remember a single bare spot. The turnips and swedes on this *sandy* land were grown upon *ridges*. There were also *white carrots*, a heavy crop; and I was particularly glad to see a 14-acre piece of *globe mangold-wurzel* of the most luxuriant growth, on some newly-broken land indeed, but land which had borne so rank a grass when in park that no animal would touch it; and it was said that even a Highland Scot, confined to this part of the park, had been starved. Mr. Burness, the Duke's bailiff, informed me that he intended to increase the growth of the *globe mangold-wurzel*; and that by his highest farming he could grow 22 tons of swedes, 30 tons of turnips, 36 tons of long mangold, and no less than 40 tons of *globe mangold*—rating the superior yield of *globe mangold* over swedes still higher than Mr. Hillyard. Mr. Burness also

told me that the *same experiment with Lord Spencer's, on the comparative feeding properties of swedes and of mangold, had been tried with bullocks at Woburn, and with precisely the same result.* He also told me that, whenever he wished to push a beast on in condition, he changed it from swedes to mangold-wurzel. The farm-yard is a vast assemblage of buildings, with sixty bullocks, chiefly Herefords, fattening in the stalls—partly on linseed, which is ground on the premises by the same water-wheel which threshes the corn. The flock is Sussex Down, but a part are crossed with the Leicesters, for one generation only of course, all the lambs being made up for the butcher. Mr. Burness stated that for this purpose he thought the half-cross was the best, as the meat fetched the same high price with the Downs (a halfpenny a pound more), while the Leicester blood gave a greater disposition to fatten. This noble farm is certainly a model of light-land husbandry; and I did not discover a fault in it. I should add that on these 1500 acres no waggon is used. The harvest is brought home and the dung carried out upon *single-horse carts*; nor in this respect is there any departure from the practice of the neighbourhood, for I find that in Bedfordshire and a part of Hertfordshire the farmers use nothing else—so that the advocates of single-horse carts need not go so far north as Cumberland in support of their innovation.

XIV.—*Account of the Meeting of German Landowners in 1841.*

By HENRY HANDLEY.

HAVING been requested to furnish an account of the proceedings of the “Fifth Meeting of the Society of German Landowners and Foresters,” which I attended at Doberan, on the Mecklenburg coast, in September, 1841, I shall endeavour to give a general statement of the objects and arrangements of the Society; but the difficulties attendant on reporting communications which have been received through the medium of a foreign language will not only abridge the matter, but, I fear, diminish the interest which I could wish to impart.

In the hope that I might furnish a more elaborate description of the proceedings of the meeting, I have waited for the publication of the Transactions of the Society, which have at length appeared in a somewhat voluminous form; but the subjects discussed at the greatest length are not of a nature to be very interesting to British agriculturists: such, for instance, as the distillation of sugar and spirits from roots; the niceties requisite in the breeding and management of merino flocks; the extremely minute tests applied to determine the quality of wools; the breeding of blood-horses in Germany; the management of the forests; local geological collections, &c. &c. I shall, however, give such extracts as may convey an idea of the character of the discussions, and a debate in full on the merits of the different breeds of dairy-cows.

The Society of German Landowners and Foresters was established in 1837, for purposes similar to those of our own Society, and is supported by the principal landed proprietors of Germany. Like us they adopt the annual migratory system. The first meeting was held at Dresden in 1837; the second at Carlsruhe; the third at Potsdam; the fourth at Brunn; the fifth at Doberan; and this year the meeting will take place at Stutgard, in the month of September.

Although its objects are the same as ours, the arrangements and proceedings of the meeting partake more of the character of the British Association. Thus, while the exhibition of stock and implements forms a secondary consideration, the main business, viz. the discussions of points connected with the science of agriculture, are carried on in sections, under the presidency of some one celebrated for his acquirements in that peculiar department, with an earnestness which marks the interest with which they pursue the theories of agriculture, and investigate the results of practical experiments.

The president of the meeting is named annually by the Sovereign or Reigning Prince of the state in which it is held. At Doberan, the Grand-Duke of Mecklenburg, a short time previously to his lamented death, appointed Count Osten Sacken, whose assiduity and obliging attention to all well justified the selection.

On the first day the members of the Society, whose names are registered on their arrival, and the list delivered each morning with their addresses to all the members, assembled in the grand saloon. The president opened the business by recapitulating the objects for which they had met, and delivered an inaugural address on the advantages to be derived from the meeting. He then proposed that the members should form themselves into sections under the presidency of gentlemen who were then named.

The sections appointed were,—On Sheep and the Management of Flocks—on Practical Agriculture—on Horned Cattle—on the Breeding of Horses—on Geology—on Agricultural Mechanics—on Pomology—on the Management of Woods.

The sittings occupied eight days. The several sections met at half-past six A.M., daily, and continued in deliberation till eleven. At noon they all assembled in the grand saloon, under the presidency of Count Sacken, when a *résumé* of their several proceedings was read, and animated general discussions ensued.

At two o'clock the members met at a spacious *table d'hôte*, at which the Grand-Duke and his family dined, and to which ladies were admitted, forming a company of nearly 700 persons. There were no toasts or speeches, the whole party being apparently intent on the one object of satisfying hunger, an operation similarly

repeated at night, though with less form, persons coming in at the hours most convenient to them, and supping in small detached parties. After dinner, which lasted probably an hour and a half, some of the sections again assembled; others attended the exhibition or trials of implements; others, the gallery of fleeces, and specimens of wools. The section of foresters, under their president, made excursions to the neighbouring woods, where they practically discussed the training of trees, &c. On the whole I am inclined to think this was at once the most numerous section, and that which created the greatest interest amongst the members of the Society generally.

The fleeces, to the number of 300, were exhibited in a spacious tent, 150 feet long by 50 wide, placed upon tables, and most judiciously arranged under the direction of Mr. Jeppe of Rostock. It is impossible for a stranger to conceive the extreme attention paid to this subject in Germany, where immense flocks are reared for their wool alone, kept, during the greater part of the year, in large barns, and so carefully attended, that neither dew nor rain is allowed to fall upon them. In the King of Saxony's flock, which I visited, I found wethers kept to the age of nine or ten years, solely for the 2 lbs. of wool which they annually yielded. If subjected to a varying temperature, or checked perspiration, a knot is formed on the staple, to which my attention was directed by a very strong magnifying power, and which very materially deteriorates from the value they attach to the article. Next to equality, fineness of texture is the great desideratum; and a beautiful machine has been invented by Mr. Jeppe for the admeasurement of the thickness of the wool, and the proof of its strength, which unites the minute workmanship and delicacy of watch-work. By this instrument 100 hairs of each fleece, selected from nine different portions of the body, forming an average of fineness, are subjected to a given pressure, which is registered on a very minute index. The result of one experiment, I was informed, was, that an Austrian fleece had been produced, of which twelve hairs only equalled in thickness one Leicester! The fleeces exhibited were sent from Saxony, Hungary, Austria, and, in fact, from every sheep district of Germany.

In the museum attached were samples of every wool in the known world, comprising even our most recently established colonies, carefully washed, weighed, and sorted, with such remarks as tended to illustrate the subject.

The section of Agricultural Mechanics, comprising the exhibition and trial of implements, was placed under the presidency of Captain Stanley Carr, an honorary member of our Society, whose residence for nearly twenty years in Germany, on a fine

estate, purchased and cultivated by him in the neighbourhood of Lübeck, has long been an object of great interest to the leading landed proprietors of Germany.

To the enterprising spirit of Captain Carr, who has availed himself from time to time of the improvements introduced into the implements and other branches of British agriculture, and whose own mechanical ingenuity has adapted some more immediately to the purposes of German cultivation, the agriculturists of Northern Germany owe much, and gratefully acknowledge the value of his example.

At least 100 Scotch iron ploughs are now to be seen superseding the "haken" of the country, forced upon the conviction of his neighbours by the superior work shown on Captain Carr's farm. I recognised the well-known names of Ransome and Crosskill stamped on his implements, skilfully worked by natives whom he had himself instructed. On the present occasion he had, at considerable inconvenience, not only furnished to the show some of the best English and Scotch ploughs, but the more modern inventions of the Uley and Biddell's scarifiers, Crosskill's threshing-machine and clod-crusher, with other implements of approved merit.

The threshing-machine was exhibited at full work in the presence of the Grand-Duchess and a large assemblage, and gave universal satisfaction. Several orders were given for new ones from England.

Nor were the native implements wanting in interest. It is true the "haken," which might be termed a "spade-plough," appears to set at defiance all the theories of draught and resistance, but it still retains admirers, for the rough mode in which it leaves the soil exposed to the winter frosts. Ploughs invented thirty years ago by Thäer, and one styled a "zucker," said to have been used by the Romans, and still to be found in East Prussia, were certainly more curious than useful; but some horse-hoes with small rakes attached, a spiked roller, a three-furrow wooden plough, 5 feet in length and 24 inches in breadth, for ploughing in wheat, boxes for sowing clover and other grass seeds, and a machine for evenly distributing powdered gypsum, which struck me to be on a principle that might be readily adapted to sowing soot, had considerable usefulness, and I have no doubt made good work.

One afternoon was devoted to the trial of ploughs, when Wilkie's Scotch plough, drawn by a pair of Clydesdale mares, the property of Baron Malzahn, held by a German ploughman of Captain Carr's, and a double-furrow Ransome's plough, astonished and convinced the spectators of their superiority. Another afternoon was devoted to the show of blood horses. About 150

were paraded in front of a stage erected for the judges. The Mecklenburg mares have been very much crossed with English horses, and are much improved; but the native breed is well calculated for harness, their fore-hands and action being showy and good, though they are usually deficient in carcass and hind-quarters.

The most interesting exhibition to me was the show of roots, grasses, and seeds. The circular music-hall of the Grand-Duke was appropriated to this splendid collection, of which there were upwards of 1000 specimens. The Messrs. Booth of Hamburg, who were the largest contributors, had 180 different varieties of potato, and furnished to the silvicultural section 100 specimens of pinus and abies from their justly-celebrated nurseries of Flotbeck. Captain Carr sent some swede turnips, weighing (September 1st) $6\frac{1}{2}$ lbs. Messrs. Booth exhibited the Siberian vetch, which is from 10 to 12 feet long; also the Siberian bear's-claw, a new plant, said to be a strong one, very healthy for nursing ewes, requiring but light land, with deep roots, and shooting early in spring. Sheep like it so well that they leave no part uneaten. Glass cases of wheats, oats, barley, &c., from various countries, and samples in ear, combined to form a very interesting and attractive exhibition. Every country has its enthusiast, and much amusement was created by a gentleman whose ruling passion was to raise a flock of merinos, fed on *mulberry leaves*. He was followed about by an ancient ram, to which he supplied his favourite food from a basket which he carried with him; but to the feeding qualities of which the appearance of the animal did little credit.

Some cows, both native and Ayrshire, and pigs of good size and fair quality, were exhibited during the week, but they appeared to be merely an average of the breed of the country, not brought from any great distance, nor prepared to be shown in competition. The object of the exhibitors appeared to be rather to sell them; and, in fact, the show of cattle had altogether rather the appearance of a market than a show-yard.

In the programme, issued prior to the meeting of the Society, were 112 questions noted for discussion, under different heads. The following were some of them:—

1. After how many years may different plants, such as rape, clover, wheat, flax, be repeated on each variety of soil, without injury to the crop?

2. Is it immaterial to the quantity and quality of the dung, by what kind of stock the fodder is consumed?

3. If two equal quantities of fodder, consisting of hay and straw, are consumed, the one by beasts and the other by sheep, will the two kinds of dung, as long as they remain in the land, produce equal crops on a similar soil? or if not, what will be the difference in their effects?

4. What has been the result of dressing peaty meadows with earth? What proportion

does the improvement bear to the expense? And how are these pastures to be permanently improved?

5. In the formation of water-meadows, what quality of soil and of subsoil, what inclination of the land, and what quality of water are to be preferred? What experience do we possess on the subject?

6. Can the efficacy of water on such meadows be increased by mixing up earth in the water? What sort of earth is best for the purpose, and in what manner is it to be mixed?

7. For the last twenty-five years marl has been generally employed in Mecklenburg with the most surprising benefit. What results do we possess as to the extent and permanency of the benefits here and abroad?

8. What different effects have been produced by the application of different marls to the same soil, or of the same marl to different soils?

9. What results have been produced by second applications of marl, with reference to the quantities applied, and the intervals of time which have passed between the two applications?

10. What effects have been observed from the application of gypsum to marled and to unmarled lands?

11. Are there any signs on the surface of the ground by which a bed of gypsum lying below can be discovered?

12. May a soil be so much impoverished by a repetition of exhausting crops that it cannot be restored in the course of years without the aid of artificial manures?

15. On what soils, and with what tillage, do peat and sea-weed act best as manures?

16. Would it be useful to moisten the sheep dung in the stalls from time to time with water, that the ammonia may be absorbed, and the dung be prevented from growing mouldy?

18. Chickory has been recommended to be cultivated for green food. Have any experiments been made with it?

21. What is the relative value of the different kinds of hay from meadows and from arable lands?

22. What effect has the trench-ploughing of wet land on its drainage, and can its fertility be so improved?

23. Is it established that inclosed lands are more fruitful than open fields, and what kind of fence is the best and cheapest?

24. Is it advantageous to plant trees on sheep-pastures? and if so, which are the best kinds of trees?

25. Has the under-drainage of the English, which was so strongly recommended by Thäer, extended itself on the Continent? and if so, what effect has it produced?

32. What is the best method of feeding horses? and do potatoes answer as well as they have been represented to do for that purpose?

33. Is it best that horses should remain always in the stables, or that they should be partly at grass?

43. How has the Ayrshire breed of cattle, now for some years introduced into Germany, succeeded as to richness of milk, fattening quality, and moderation in feeding?

44. What sort of food answers best for cows, in regard to health, quantity and quality of milk?

45. Does the goodness of milk, and of the butter obtained from it, depend on the proportion of its chemical constituents?

46. Is it possible to obtain butter of equal quality throughout the year by varying the food of the cow, and by the mode of preparing the butter?

47. Should stalled cows receive their water rather in the stall than out of doors, and warm water rather than cold?

48. Has the mode of keeping and feeding calves any effect on their future yield of milk?

49. Can equally good and strong cattle be reared by entire stall-feeding as by feeding at large?

50. What is the best method of testing the milking quality of a cow, regard being had to her requirement of food?

61. In sheep of unequal size, but of the same race, does the consumption of food differ according to the size of the animal?

Some extracts from the discussions on the different questions

may interest the members of our own Society. On the first question, the recurrence of the same crop, Professor Schweizer remarks:—

“ With respect to the repetition of red clover, we have had abundant experience in Saxony. Where the soil is neither too loose nor too close, is deep, so that the plough can go 8 inches down, and is also rather moist, clover is the most certain, and may be repeated most frequently, not only every six years, but, with high farming, even every four years. On an inferior soil we may be quite certain that clover will not do well every four years, as has been proved in the neighbourhood of Dresden, where the land is completely clover-sick. The chairman gave his opinion that a repetition of red clover after six years was allowable everywhere; that in favourable soils five years might be a sufficient interval, but that to bring two crops of clover nearer together was always doubtful, and could only be regarded as an exception.”

On the 7th, 8th, and 9th questions, which relate to marling, there are some important statements. Thus Mr. Hilmers, Quambeck, stated that

“ He had found the good effect of a dressing with marl for thirty years. At first it was so astonishing, that on fields which previously produced only bad buckwheat, he had been able, after marling, to grow good wheat. As the effect began to fail in the third eleven-years’ course, he gave another slight coat of marl, about 4 cubic feet to a square rood of 16 feet, and had found it answer, particularly with rape, barley, and clover, though not quite so well as the first time. His soil varied in quality, some being loamy, some peaty, and a part of it sandy. The first marling had been twice as heavy,—5 cubic feet to the square rood. In his second marling he had once applied more than that, but it had done harm. The marl was good, and very full of lime. He considered the kind of marl and also of soil to which it was applied very important. On peaty and light land a clay marl does much more than a sandy marl. Sand-marl works quicker than loamy or clayey marl, so that less need be used, but its effect is less lasting. It makes a sandy soil too loose and hot.

“ Count Holstein brought forward as a proof in favour of repeated marlings, a district in his neighbourhood, the provostry of Pretz, which had become famous through the use of marl. In the provostry, he said, marl had been used for two generations, and at first its effect was so great, that the farmers thought dung superfluous on the marled land. The consequence was, as might have been foreseen, that the fields so neglected gradually diminished in produce, and it was discovered at last that marl could not supply the place of dung for ever, but that dung and marl must be used together. But in spite of this ill usage of the land, and of a very scourging rotation, it had not been difficult to restore the land by good dunging. Marling was still continued, a great deal of land had been marled two or three times, and the whole country was in a blooming condition.”

There are some remarkable observations on the question whether

gypsum acts best on marled or unmarled land, which bear on the general question of the use of that mineral:—

“ Mr. Pogge-Zierstorff admitted that gypsum had some effect on unmarled land, particularly on one farm of his, consisting of strong loam; but said that it had no decided advantage until after marling, and that the effect was better the oftener it was applied. This was a common observation in Mecklenburg. Some of his fields had received ten dressings of gypsum, and always with good effect. He only used half a pound to the square rood, and applied it to clover, pasture, leguminous plants (peas, beans, or tares), wheat, &c. He now used 30 tons of gypsum every year. Gypsum would not act if the usual dunging were given up.

“ Mr. Thäer confirmed from his own experience the better effect of gypsum on marled land.

“ Mr. Harbe had found that gypsum acted far more on strong land than on weak and light land. It was well known, he said, that gypsum did most on clover and peas. After peas dressed with gypsum, he got good oats, but gypsum put on the oat-field did no good.

“ Messrs. Schweizer and Satow-Hügerfelde observed, that gypsum only worked well on land where there was vegetable mould; hence its better effect where the land had been improved by marl and dung.

“ Dr. Schulze remarked, that where gypsum had been found to act either remarkably well or otherwise, the soil ought to be chemically examined in order to trace the mode of its action.

“ Professor Lumbe observed, that moisture must be important in the action of gypsum, for its effect was not good unless its application was followed by rain. This might be accounted for by the circumstance that it requires 500 times its own weight of water to dissolve it.

“ Mr. Harbe and others spoke of the advantage of sowing the gypsum on clover-fields in winter while covered with snow.

“ With regard to the application of gypsum either to meadows or to peaty pastures, the experiments reported were contradictory.

“ On another occasion several members stated that the effect of gypsum frequently did not appear until it had been repeated several times.”

In the discussion on the 15th question some strong facts are brought forward in favour of applying peat as a dressing to heavy lands:—

“ Messrs. Mantzel, Hold, and Pabst recommended its being mixed with dung in compost heaps. Professor Schweizer, to lay it under straw in stalls. Mr. Klitzing had derived advantage from applying a mixture of peat rubbish and ashes to stiff land. Director Pabst called attention to the report of the Baltic Agricultural Association in its favour. Mr. Nathorst, from Sweden, said, ‘ I come from a country where peat has been used for seven years as dung. It is used there on all kinds of land which lie high, but not on low ground. We think the higher and warmer the land lies, the better for this manure. To lessen the cost of carriage we lay it in small heaps where it is cut, that it may be drier and lighter. A farmer who has used it for the last six years has

doubled his crops. He lays it on his fallows in June half an inch thick, and finds it last longer than dung. The land is ploughed once in the previous autumn and twice in summer, before the peat is laid on, which is broken small with hoes. Afterwards it is ploughed in very shallow, or the land is merely scarified.' Mr. Hilmers, from Holstein, had laid peat an inch thick on a strong loam, and also on sand, with advantage. Mr. Thäer found peat rubbish act best upon sheep-pastures. Another member had used it largely on loamy land, and known its effect last as long as ten years."

There arose a considerable debate on the merits of our own breed of Ayrshire cattle, which I am tempted to give at length as it is printed in the Report of the Meeting. The Chairman read the 43rd question on the list :

" ' How has the Ayrshire breed of cattle, now for some years introduced into Germany, succeeded as to richness of milk, fatting quality, and food ? ' "

" In order to answer such a question we must first decide what we should call richness of milk and moderation in feeding, and we must therefore join the 50th question with the present one, namely :—

" ' What is the most approved method of testing the milking qualities of a cow, due regard being had to her requirement of food ? ' "

" We have then to compare the Ayrshires with our own German breeds ; and I must recall to you the excellent observations which Mr. Riedesel made, at our meeting in Carlsruhe, on the feeding of horned cattle, and on their produce. These will be found in the printed report of that meeting. Without entering into the details of his statement, I will only observe that his leading principle agrees not only with all my former experience, but also with the inquiries I have since made on the subject. That principle is, that we should supply cows with abundance of food, and in equal quantity at all times. I will now, however, only state to you his principal figures. Mr. Riedesel assumes that the quantity of food required for keeping up the actual condition of a beast is one-sixtieth of its own weight—either hay, or so much of other food as is equally nourishing with that amount of hay—that only the food which is given besides this necessary allowance produces either milk or meat, and that, if we would feed profitably, we must give double the amount of the necessary allowance—that is, one-thirtieth of the live weight, in hay or its equivalents—that then a good cow, for every pound of this extra allowance of productive food, that is, for every two pounds of the whole supply of food, would yield one pound of milk. Thus a cow weighing alive 1000 lbs. must receive daily $33\frac{1}{3}$ lbs. of hay, or the equivalent either in pasture or in stall-feeding, for which she would return 2190 Berlin quarts yearly ; or, deducting what nourishment is required for her calf before its birth, 2000 quarts, which our best cows will certainly give when allowed to feed at large. In practice, it is true, we cannot measure the food so accurately as this, still these estimates afford a valuable standard for our calculations.

" With regard to the immediate question of the Ayrshire cows, it will be very interesting if we obtain facts on which we can depend re-

specting their yield of milk. I have heard of no breed in England or Scotland that yields so much milk for so little food as the breeds already well known in Germany for their milking qualities, such as the Dutch and the Swiss. On the other hand, the English breeds, six of which we have imported and tried, are unrivalled for their tendency to gather meat; I am desirous, therefore, to hear how far fattening propensity has been reconciled with milking quality in the Ayrshire breed of cattle.

“ President Pogge.—I was led by the high expectations formed respecting the Ayrshire cows brought into Pomerania in 1837, and by the favourable opinion of Captain Carr, to persuade my countrypeople also to introduce a herd of them, and by his aid we bought 105 heifers, of which I had myself twenty-two. The best of them gives 22 potts daily, a great yield for Mecklenburg. Of all the breeds I have known, Tyrolese, Swiss, or Holsteins, I look upon these Scotch cows as the best. For our husbandry they are a real treasure. They are equally good for milk and for meat. It is true I have made no accurate experiments on the milk they give, or the cream produced from that milk. Such experiments have been carefully made in England, and I have had no occasion to make them; for the mere sight of these beautiful cattle in the stall or in the meadow, is enough to convince any one that they far surpass any other cattle we have bred here. Others, however, have examined how much butter their milk will yield, and have found that it varies with different cows. Sometimes 11 or 12 potts of milk give a pound of butter, sometimes 7 or 8, which proves the richness of their milk. I will only add that, like the English pig, the Ayrshire cow is very moderate in its food, and gives a great deal for what it receives.

“ Mr. Thäer.—I wish to observe, that from what I have heard of the way in which the Ayrshire cow is brought up, I am inclined to suspect that the manner in which cows are reared has great influence on the milk which they yield. Captain Carr can inform us in what way the Ayrshires are brought up.

“ Chairman.—That belongs to Question 48.

“ Dr. Kuers.—Mr. Pogge has mentioned that experiments have been made in England respecting the milking qualities of the Ayrshire cows. I have read all the new English works on Agriculture, but I know of no such experiments; and I must remark generally, that the experiments made in England, on the relation between the quantity of fodder given and the amount of produce obtained, are not made so accurately as to inspire me with much confidence.

“ Mr. Frehse.—The superiority of the Ayrshire cows is so well known in England, that probably it is there thought unnecessary to prove it by figures.

“ The Chairman.—The Ayrshire race is renowned in England because the other breeds there give so much less milk. Whether the Ayrshires are superior to our breeds also in their yield of milk remains to be proved.

“ President Pogge.—It seems to be proved by what is taking place in Holstein, which is so famous for milch cattle and dairy management. Yet even there they are contending with each other for Ayrshire calves; and indeed Holstein is following our example by sending to Scotland

for the original breed. Let us be glad that in breeding cattle we do not make the mistake that we made in the attempt to improve our horses, which advanced so slowly because we disliked to admit what was good from England.

“Chairman.—As the Ayrshire breed has been five years in this country, perhaps some one can communicate some accurate trial of their milking qualities as compared with our breeds.

“Captain Carr.—I think that, in order to get what is best, we must throw all prejudice overboard. Those whom I see around me will think it equally unwise to adopt everything English without inquiry, and to reject what is good because it is foreign. It is a mistake, I must say, to suppose that no accurate trials of this breed have been made. They may be seen in Sir J. Sinclair’s *Code of Agriculture** and elsewhere. But these trials are like those of threshing-machines. As you feed the threshing-machine, and according to the quality of the wheat to be threshed, so will be the yield of the machine. If the cow is half-starved, she brings no profit. If she is of a good milking, and not of a fatting breed, and is kept well from her birth, I think dairying will be profitable. For our climate the large English breeds, Shorthorns and Herefords, do not seem to be suitable. I have found the Ayrshires do well here, but I am sure that those large English breeds could not have withstood many dry seasons which I have seen in this country; for though they eat but little for their size, they would have died when our grass failed altogether.

“A Member.—For my part I think we have milch cattle of our own which answer our purposes, and that they would stand in much higher repute, and be more valuable, if we took more care in breeding and rearing them. The yield of these foreign cows does not appear to me very large; and I assure you that I have cows of this country (well reared, indeed, and well fed) from which I have had 23 or 24 potts of milk in two milkings.

“Baron Malzahn Sommerstorff.—In the year 1837 I went into Scotland on the part of an association in Pomerania, and bought 185 Ayrshire cows. It may interest you to know the results of trials which have been made respecting them in their own country. There it has been established that, with moderate keep in summer and winter, such as we are able to give them, they give more milk and more butter than any other breed. With abundance of good food one of these cows has been known to give 30 quarts of milk a-day; and 8 or 9 quarts of her milk have yielded a pound of butter: none of our own breeds can do this. Ours give only 12 or 13 quarts of milk. The best of them certainly produce a pound of butter from 10 or 11 quarts of milk. I am far, however, from rejecting our own breed altogether; and I agree with the last speaker, that any breed may be improved: but our breed wanted new blood, for we had neglected it—and I thought we could not do better than adopt the experience, now 200 years old, of a Scotch county. The way too in which these cattle are reared should be recollected. The calves are kept on Highland pastures until they are nearly two years

old. This hardens them very much. I have found no breed that gives so much milk upon moderate food as these Ayrshires.

“Count of Holstein.—Mr. Pogge has mentioned that we have formed a society in Holstein for the purchase of Ayrshire cows. That is true; but we have no experience of them at present. We mean to buy them, because we read in so many books that the Ayrshires with moderate food give more butter than other breeds. We do not expect more milk from them than from our own marsh cattle; on the contrary, I think they will give less milk. I have had marsh cattle, of which I got the ancestors out of the marsh, for the last ten or twelve years on my own pastures, and I find them answer. On good feed they do well. It is true, the marsh cattle are too heavy: my own are too heavy for many districts. As for the Ayrshires, I wish that in Mecklenburg you would make some experiments on their produce and on the cost of keeping them, and I will particularly ask Mr. Pogge to do so.

“Mr. Pogge consented, and stated further that he had found the Ayrshire bulls make a most excellent cross with the Mecklenburg breed, and that his neighbours brought their cows to his bulls from a great distance.

“Capt. Carr.—I beg to add, that the excellence of the Ayrshires as milkers is fully confirmed in the Agricultural Report on Ayrshires by Mr. Ayton, but I do not know that our climate will allow us to do so well with them as is done in England. Our changes of temperature are so much more sudden, and our cold more severe. There the cows can go out upon a meadow for a few hours almost every day in winter, and they are not kept upon straw and bog-hay. Many of them never taste straw, but get the finest hay and turnips, as much as they can eat; and frequently meal-water or a soup made with steamed turnips, beans or peas, and hay-tea, for which food each cow gives from 300 to 400 lbs. of butter a-year. Here, however, I do not expect more than 150 lbs., even for Ayrshires; and I believe that our own best breed, those from Angeln, do not give more than 120 lbs.

“Mr. Pabst was very desirous that more trials should be made, as he thought when animals had been bought at a high price they were often fed so well that they appeared better than they really were.

“Mr. Stanginer said that he had put two Ayrshire cows and two of his own cows (supposed to be from Angeln) in a grassy paddock. The two Ayrshire cows gave $32\frac{1}{2}$ potts per day, the two others 29 potts. The Ayrshire were the hardiest, but their milk was not richer.”

The Chairman then closed the discussion by saying,

“I beg to sum up this interesting debate thus. No man rates higher than I do the unrivalled achievements of England in breeding, of which I convinced myself by what I saw in that country. In their cattle particularly they have reached perfection; but the tendency of their farming is to encourage fattening quality. The Ayrshire breed seems to me, more than any other British breed, to unite with that hardiness and milking quality too. If we are in want of English or Scotch blood here, I think the Ayrshires would suit us best, and we are much obliged to Captain Carr for pointing them out to us. It is not, however, quite

clear to me, that if we bestowed pains on our own cattle they would not be equally good, at least in respect to milk, which for us is the principal point. I hope that this discussion will lead many German farmers to make experiments on our own cattle, and to let them be publicly known."

The following remarks were made on Question 46:—

"Is it possible to obtain butter of equal quality throughout the year by adapting the food of the cow to the season?"

"Mr. Hilmers thought it was impossible.

"Baron Eckardstein.—In England experience has shown that the cow on good natural meadows gives not only more, but also richer and more agreeable milk than upon a clover piece, or than when she is kept at home in a stall.

"Mr. Karbe.—Still it appears that such management would not be quite impracticable, for on the farms around Berlin they produce butter with hay and meal only, which is not at all inferior to grass-butter.

"Mr. Thäer.—When cows receive green food in their stalls, or even when they graze, their produce in milk and butter falls off in autumn, and the butter loses flavour; but if you give them green maize to eat at that time, they yield more milk and the butter improves in flavour.

"Mr. Neergaarb.—Complete regularity of produce all the year round is unattainable; but that something may be done I have no doubt. Clover-hay and salted green food improve the milk for churning.

"Mr. Klitzing.—For many years I have sent fresh butter to Berlin, and I attribute the goodness of my butter to the refuse of distillery which I give to my cows.

"Mr. Karbe agreed with the last speaker.

"Mr. Teichmann.—Dividing the calving of the cows regularly through the year gives a steadier quality of milk. We do this in Saxony, so that we have always young and old milk together."

I will only add a few remarks made on Question 61, which, though rather of an abstract nature, may deserve consideration:—

"In sheep of unequal size, but of the same race, does the amount of food required by each, stand in proportion to the size of the animals?"

"Mr. Thäer thought that the smaller animal required somewhat less food in proportion, which he ascribed to the linings of the bowels acting more thoroughly on the digested food. That there appeared, however, to be exceptions among sheep, because the smaller animal might produce most wool, and the production of more wool would require a larger supply of food.

"Count Holstein.—According to the English the smaller sheep always eats less in proportion.

"Mr. Thäer.—The observations of the English are confined to the production of meat. But a pound of wool requires as much food for its production as 8 or 10 pounds of meat, without reckoning the grease that lies between the wool. He then entered upon the observations of the well-known French agriculturalist Mons. Rivière. For many years Mons. Rivière had kept large and small oxen and sheep, which he sold

by weight. He found that the small animals paid double the profit of the larger ones."

The Meeting was concluded by horse-racing, and a fête given by the Grand-Duke to the peasantry: the members who attended amounted to 900; of these the greater number were proprietors of the North of Germany, but scarcely an Agricultural Society of any note throughout Europe omitted to send a representative.

That this Society is on a scale to work very great improvements in the agriculture of Germany there can be no doubt. If I were to form an opinion only from what I heard, I should say it has already materially changed the cultivation of the North; but the rigid adherence to old customs displayed throughout Mecklenburg in the management of the farms, at least leads me to the belief that improvements in practical agriculture are as tardy in their advance there, as I fear it must be admitted they are in many parts of our own country.

In Mecklenburg, and indeed its neighbouring states, one obstacle to great improvement is to be found in the few wants of the occupiers. Wealthy in the possession of the means of living comfortably, with the certainty for the most part that the same means will be continued to their children, they are little disposed to exertion. It may not be uninteresting to add a few remarks which I collected as to the tenure of land and general statistics of Mecklenburg, a country with which we are likely to be more and more connected, not only in the intercourse of commerce, but because of the warm feelings entertained towards England by its hospitable and intelligent inhabitants.

In Mecklenburg the tenure of land comprises, 1st, the domains of the Grand-Duke; 2ndly, the seignories, or estates of the nobles. About seventy years ago this privileged class solicited their Prince to permit the acquirement and holding of lands by persons "not noble;" the result was an immediate increase in the value of estates, as the competition for purchase increased.

At present there are 987 large estates in Mecklenburg-Schwerin, of which 67 belong to the Grand-Duke as reigning Prince, 10 his private property; 78 belong to 23 Counts of the Duchy; 360 to 257 other nobles; and 338 to 279 persons "not noble:" 14 religious institutions possess 86; 17 corporations, 42; and 6 peasant communities possess 6 estates. These tenures are further classified:—1st, the "*lehn*," or fief-land granted by the Prince upon condition of certain assistance and duties in war from the *noble* holder, reverting to the donor in the event of the family becoming extinct; he cannot, however, appropriate it to his own use, nor sell, but confer it upon a "*noble*" subject.

Many estates are called "*majorat*," or entailed upon the eldest son: some few "*minorat*," in which the youngest inherits. A

3rd class is called "*fidei commesse*," where all the sons have equal rights, and cast lots for the inheritance. These three classes of land can never be sold unless where there are but two heirs to give consent, in which the Prince must concur.

The other seignories are called "*allodiale*," titles derived from the strength of the position, or the bounty of the Prince; they may be held by any one who can purchase them, are privileged in all respects like the others, and may be sold by the owner without the consent of the Prince. Each seignory has its own jurisdiction, and the proprietor his seat in the "*landtag*," or provincial Parliament. The course of justice is short, simple, and attainable by the humblest against the most wealthy and noble. Formerly every "noble" held his own Court, and did much as he pleased with his serfs; but now he cannot be a judge in his own case, even in the most trifling matter. His deputy, who is a barrister, approved by the Chancery, is sworn to do impartial justice, and must send in written details of all his acts and proceedings to the superior Courts, where they are carefully scrutinized; nor can he award the most trifling punishments without their approval. The police-duties are performed by one or more policemen on each estate: there is also a mounted and well-appointed *gens d'armes* force of about 80, who ride over the duchy, and are well informed as to what passes, without being troublesome to any but the evil-doer. There is but little crime—no beggary—and but one workhouse in the whole duchy, for a population of nearly 500,000, in an area of 4836 square miles. There are schools under the superintendence of the clergy in every parish, and generally also on the large estates. Parents are bound by law to send their children from five years old until they are confirmed, at fourteen or fifteen: hence arises the circumstance, which, until thus explained, struck me as remarkable, the absence of all young persons from the labours of the field, which are carried on entirely by adults. Until confirmed, they have no civil rights—cannot be bound to any trade—nor marry. At seventeen all the young men are inspected by a general-officer and his staff, and those found eligible ballot for three years' service, after which they join their regiment for drill only four weeks in the three subsequent years, when they are free, unless called out in the event of war: about one in twenty is required to fill the ranks.

No young peasant can marry until he is free from all military obligations; and he must even then procure the consent of his landlord, who in that case provides him with a dwelling. The small population and numbers of public works which furnish so much employment obviate all difficulty. The domains of the Prince are all let—generally in large farms, for terms of one, two,

or three rotations. The “bauer” (peasant) generally holds from 50 to 200 acres, paying a small rent. The holding descends to his children, and he can sell his title, with the consent of his lord, to tenants holding for six or eight years. On the domains of the Grand-Duke, the “Amtmann” of the district not only receives the rents, and acts as seignor in all things, but prescribes the rotation and management of the farm in all things. If the farmer should be a bad manager, he is deposed, and his son or next of kin put in his place. This is, however, very rarely the case, and this class of tenants are very well used, whether in the royal domains or on the seignories.

About one-fourth of the province is cultivated by the resident proprietors, who keep intelligent bailiffs, and who pursue country amusements during nearly the whole year. It is on these estates the greatest improvements are making, and through their exertions and example will, I have no doubt, be gradually extended. When, however, it is inconvenient to reside, the lands are let in farms varying from 500 to 1200 acres, on leases for two or three rotations, which are generally as follow:—

1. Fallow, dunged.
2. Rape, rye, or wheat.
3. (After rape, wheat), otherwise barley or oats.
4. Oats.
5. Clover, mown for fodder.
- 6, 7, and 8. Pastured.

Sometimes, where there are meadows, and therefore an unusual quantity of manure, the third year peas are grown with half dunging, and the fourth year, rye. The land is for the most part sandy, but in some districts with such an admixture of clay as to form excellent corn-land. The three or four white crops in succession are here ruinously general. Potatoes also, for winter food or distillation, are much grown. There is very little natural pasture, the cattle being for the most part brought from Jutland and Holstein. Farm-buildings are numerous, and of immense size, as not only are all living animals housed during the winter, but until latterly no corn was stacked out of doors. In many cases the dwelling-house of the tenant consists of one end of the barn walled off. The residences of the nobles, however, and their establishments, vie with the best appointed country gentlemen’s houses in England. Wages are from 10*d.* to 1*s.* In threshing, however, the pay is the 14th sack, equal to about 1*s.* 2*d.* per diem. In Prussia, I believe, it is the 16th sack. The sale of horses is a very important traffic, bringing perhaps 200,000 louis-d’ors annually into the country. The number of fine-woolled merinos amounts to about a million and a half. Owing,

however, to the depreciation in the value of wool, and the increased demand for meat, many have expressed their intention to try the substitution of Southdowns. The country is open, well wooded, and interspersed with beautiful lakes; the roads are everywhere improving, and give employment to an immense number of hands. The poor are at all times but few, and, by law, each locality provides for its own, either separately or in common with others. The land-tax is the chief source of revenue to the government, which is mild and paternal.

XV.—*On the Marling of a Light Sandy Soil on the Duke of Bedford's Farm at Woburn.* By CHARLES BURNES.

To Francis Pym, Esq.

SIR,—According to your request I send you an account of the claying of our light soil. We find it of great advantage; it makes the straw much stronger, with a better ear, and standing much better up in wet seasons: when we dress high and do not clay we are very subject to have the crops fall down and get spoiled: I likewise find claying of great advantage to the turnip-crop.

My system has been to put the clay on the clover-leys as early as the crop is off, and then get it broken in pieces as much as possible before it is ploughed in for wheat; I also lay it on the turnip fallows early in the winter, so that it may have the chance of the winter and spring frosts to get well pulverised before it is ploughed down: this I prefer to claying on clover-leys.

To try the experiment, we clayed last summer 4 acres and left 2 acres not clayed on an old sward and light soil; the clay was put on in July and lay all the summer, was ploughed up in November and pressed, and the wheat dibbled into the pressed grooves: in February we top-dressed the 6 acres with good farm-yard dung, and as late as the beginning of May I thought there would not be half a crop, although plenty of ends; but towards the middle of the month the clayed part began to look of a much darker appearance than the 2 acres which were not clayed; and at the present time I believe there is above one-third part more on the clayed than on what has not been clayed, although managed in every other way the same.

In January, 1841, I clayed some land which was going to be a turnip-fallow the following summer, and in the month of April, when I began to harrow and plough the land, the clay broke down and slacked like lime, and worked in with the soil. I did not see much difference that summer in the turnip-crop, as the other part of the field was sown at a different time, and I was not

able to tell the difference; but this year the barley looks much stronger and stiffer in the straw and stands much more upright than on the land which was not clayed, where the greater part of the crop is down on the ground, and, should we have much rain, will be rotted.

The quantity per acre is generally fifty loads; if more is put on I should recommend it to be done at twice, as, in my opinion, more at once would do harm. Nearly all the light soil on the farm of the Duke of Bedford at this place has been clayed, and a great deal of it twice, and in every instance we have found its beneficial effects. The clay may be dug from the pit at any time when most convenient for the farmer, and, if turned over once or twice, will mix much better with the soil, but will be attended with more expense; my plan has been generally to dig and cart the clay on the field at once.

I am, Sir,

Your most obedient and humble servant,

CHARLES BURNES.

Park Farm, Woburn, 28th July, 1842.

The clay employed contains a great deal of lime, and is, in fact, a stiff marl.—PH. PUSEY.

As regards the application of marl or clay to sandy land, the quantity used in my neighbourhood has varied from 50 to 150 yards per acre. The smaller quantity I think, upon the whole, is best, as it mixes more steadily with the soil, and, though it may not be quite so durable, comes sooner into operation. I have applied it to clover-leys in the summer, and to the turnip fallows at different times. I think the best plan of all is to have it dug in the winter, and to cart it upon the turnip-land in the spring after it has had some months to dry; the carriage is then somewhat lighter, and, as the days are then longer, more is got in in a day.—F. PYM.

XVI.—*On Claying or Marling Land.* By F. W. OVERMAN.

To Ph. Pusey, Esq.

SIR,—Having been requested by Lord Charles Russell to write to you on the application of marl and clay to land, I may state that I entered upon my farm in the year 1814: it had been farmed for some years by that great patron of agriculture the late Duke of Bedford, and consisted of 630 acres, part gravel, part sand, part moorland covered with rushes, and some strong clay-land. I found that I did not grow the quantity and quality of corn which the land ought to do from its condition; and having seen upon my brother's (Mr. T. R. Overman, Burnham Sutton, Norfolk) the good effect of claying land, I determined to clay mine; I have

since gone over 420 acres, in every instance with good effect. Upon the gravel and sand land I put 40 loads per acre (my carts hold 40 bushels); on the moorland, 70 loads. I give my men 3*d.* per load to fill and spread, and they earn from 2*s.* 3*d.* to 2*s.* 6*d.* a-day: I do it either directly after harvest or in the winter if a frost, but prefer the former time, it going on with less labour to the horses, and not cutting the land so much, and generally you have less work on your farm at that time for both man and horse: the clay then gets dry, and as soon as rain comes may be harrowed about, when it will immediately begin to act beneficially to the land by correcting the acidity, of which most lands have too much, thereby making food for plants of what was inert in the soil, and giving the land that solidity which is requisite. This year I have some rare instances of the good effects of it: I say rare, for I do not recollect ever having seen so much good resulting from it before: in one instance, where a field was clayed 14 years since at the rate of 40 loads per acre, with the exception of a small land about 4 yards wide, upon which the turnips are entirely gone off from graping (some call it fingers and toes), in the remainder of the field the crop of turnips is excellent. I have both marl and clay on my farm, and always test them by vinegar; if they effervesce I consider them good. Upon trial of the clay I put upon the above field, I found, when first dug up, that in vinegar *it was quiet*; it had the appearance of brick-earth, rather inclined to be yellow, and very tough: still, as I had no other near that field, and it must either be that or none, I took a lump of it home, and laid it on the hob of the stove near the fire to dry, and then tested it with vinegar, when I was pleased to find it effervesce: this determined me to put it on the land and let it have all the benefit of the sun in the summer, and the result is as above stated. Another instance is the effect on moorland: in September 1835 I put 70 loads per acre of marl, blue with some chalky particles amongst it, upon 7 acres; wet weather prevented me finishing the remainder of the field (*viz.* 7 acres). The next spring this field was sown with oats—by far the best crop where the clay was; the next year turnips—very grand as far as the clay went, the remainder came up and died off in a few days; afterwards sown with rape, but it was ordinary: the next year, barley after the turnips, 6½ qrs. per acre; after the rape, oats, 4 qrs. per acre, light and ordinary: in 1840 the remainder of this field was clayed, and this year a great crop of barley *on every part*. Land will not always show the benefit it derives from clay in the first crop, which is the reason it is condemned by some persons; others dread the expense, which after all is but little. A man, to carry on his business well, and to be always in season, must have a sufficient force of horses: this will enable him to clay his land; he will always find men ready to fill

and spread at 3*d.* per load—costing the small sum of 10*s.* per acre for permanent improvement of his land. Some farmers prefer lime to clay on light land—a little reflection will show them their error; lime, I admit, will correct the acidity, but where is the solidity that is so desirable in such land? I have found it make my light land lighter still.

I likewise have two trials that I have made with chalk on strong land, that always ploughed so badly that it was difficult to get the corn sufficiently covered to vegetate. I should say that I had to fetch the chalk 6 miles—an expensive job; but as they were small experiments I wanted to make, I did not take the expense into consideration: the result is, the land now works without difficulty; and I had an excellent crop of wheat on one of the spots.

To sum up the benefits of clay to land in various ways, it is by correcting the acidity, and giving solidity; by stiffening the straw, and increasing the quantity and quality of the corn; by preventing mildew, which this farm was always subject to, but which, since I have clayed, it has not been; by preventing turnips being diseased by graping; and adding that to the soil which clover likes, more particularly the white or Dutch clover.

Apologizing for the length of this letter,

I beg to remain, Sir,

Your obedient servant,

F. W. OVERMAN.

Maulden, Oct. 24, 1842.

XVII.—*Early Vetches.* By WILLIAM JONES WILLIAMS.

To Ph. Pusey, Esq., M.P.

MY DEAR SIR,—I hasten to answer your inquiries as to the vetches which you exhibited to the Society on Wednesday last; and I hope the information I shall give may be the means of producing many such pieces of sheep-keep next year as I was fortunate enough to obtain both this year and last.

1st. Name of variety?

They are known in this neighbourhood by the name of the “racers.”

2nd. Time of sowing?

I planted them on the 26th of August last.

3rd. Quantity of seed per acre?

Two bushels of rye and 2½ bushels of vetches: but, from the rye being imperfect, I am satisfied not more than 1 bushel grew, which was quite sufficient; and I shall not use more than 1 bushel

of good rye hereafter. The rye should be sown on the furrow, and the vetches DRILLED across, which seeds the land all over beautifully.

4th. Previous condition of land, with quality and exposure?

The condition was by no means excessive—having been clover, the second crop fed for wheat; then manured with stable-manure for swede turnips, half of which were carted to an adjoining field; afterward drilled with barley, which was carted in time to get in the vetches by the 26th of August. The quality of the land is of a moderate description: light-red in colour; subsoil in one part chalk, and the remainder gravel; not of sufficient strength to grow good wheat, but what is called in this county pretty little land. As to exposure, you well know the wild, unprotected nature of our country—not a tree or hedge-row to shelter us. This particular field has on the north side the Ilsley Down, and on the others plain open arable fields; the only sort of protection being a bank and dead hedge, to keep back the sheep which fed on the downs.

5th. Time when feeding-off began, height of vetches at the time, and bulk per acre?

I began feeding on the 5th of May, when the bulk was as much as could be grown to be eaten—*i. e.* any increase of growth would have been attended with a corresponding rottenness at the bottom: when raised up from the ground they were as high as the hurdles, and well-blossomed. They were fit for feed a fortnight before I began them; but, having a plentiful supply of swedes, I did not want them before. My cart-horses were well pleased with the rye (which was too old for sheep) after it was taken from the cages; thus I derived a double advantage.

6th. The degree of forwardness of other crops of vetches in your neighbourhood at the same time?

So far as I am aware, no others were at all like them; and as my neighbours, besides very many people from all parts who attended our early sheep-markets, spoke of them as very extraordinary, I believe none were so good at that early time—a time, be it remarked, when we are generally wofully ill off for sheep-keep (having no water-meadows), and often obliged to support them on artificial food, at great cost and annoyance.

7th. How far do you attribute the superiority of your crop to the variety; how far to the early sowing; how far to the abundance of seed used; and how far, if at all, to the intermixture of rye?

The variety is undoubtedly more hardy, and at least 10 or 12 days earlier in their growth and fitness for feed; they will contest the right to grow with rye successfully, which no other sort will do. I think the early sowing assisted most materially, inasmuch

as getting the whole surface of the soil covered before winter I consider to be necessary towards early production. Thick planting, of course, assists also in what I have just related; and I believe the intermixture of rye to answer the double purpose of keeping the white spring-frost from the vetches, being somewhat higher, and afterwards supporting them to a considerable degree; which allows a circulation of air at the bottom, which otherwise would not be.

Having now described as nearly as possible the soil which produced, and the cultivation of a crop you were pleased to feel interested in, I hope it will be considered by my brother-farmers who have not yet tried them; as I know they are well worthy any man's attention.

Sir, I beg leave to subscribe myself

Yours, very respectfully,

WM. JONES WILLIAMS.

East Ilsley, June 6, 1842.

XVIII.—*On the Cultivation of Lucerne.* By JOSHUA RODWELL.

AMONG the crops not commonly cultivated, our late much revered patron of agriculture (Arthur Young) has enumerated lucerne; and he says in his Suffolk Report (p. 140), it is "not cultivated to my knowledge by any farmers, but some gentlemen have it in small pieces: I have had many acres, enough to prove it an object deserving great attention." 1803. The Earl of Albemarle has tried it on a large scale at Elden, but the experiment is not of sufficient standing yet, to ascertain how far it will succeed, on a rather poor sand.

In 1806 my attention was first turned to the cultivation of lucerne, by the opportunity of witnessing and closely examining the progress of the experiment above alluded to at Elden, in a field of 12 acres, every particular of which was readily furnished to me by his Lordship, with that kindness and urbanity which has always distinguished him not only as the patron and benefactor of agriculture, but as the practical farmer.

The following statement, which was furnished to the National Board of Agriculture in 1811, will show the success with which I followed up the cultivation of this valuable plant at Livermere, near Bury St. Edmund's, at that period:—

1807. In a field containing 11 acres, soil dry and sandy, upon a substratum of loamy gravel, the sowing of barley after turnips was completed, and with it 20 lbs. an acre of lucerne, seed sown

broad-cast and harrowed in with the barley, in the same manner as clover and other artificial grasses are sown.

1808. In the spring of this year, after the first mowing, the whole field was manured with soot, at 30 bushels per acre, after which it produced two other mowings.

1809. Part of the field was again manured this year, and the mowing was commenced on the 23rd of May: this mowing, with a small addition of oats, supported thirty horses seven weeks; the second mowing supported twenty horses seven weeks entirely; and the third mowing, with a small addition of oats, supported twenty horses six weeks. The produce of this year, at a moderate estimate for the keeping of the horses, amounted to 11*l.* per acre, after deducting all the expenses, rent, and other charges.

1810. The first mowing of this year supported thirty-five horses eight weeks, with a small addition of oats; the second mowing nearly the same; and the third mowing, although not so productive, was of great value in an occupation of nearly 2000 acres of arable and heath land, with a very small proportion of pasture.

All the above particulars, with the details, having been furnished to our National Board of Agriculture (for which in 1811 they were pleased to vote me one of their medals), gave an impetus (by its publication in their Reports) to the cultivation of this valuable plant, upon a *practical* and extensive scale hitherto unknown. Having ever since that period continued its cultivation upon the same system, and to the same extent, with unvaried success, I am now desirous of again directing the attention of every farmer to this subject, by placing before them the result of my experience in former years, as well as in the year last past, that its beneficial effects may, through the organs of our Journal, be again diffused, so as to make it still further known, it having been justly remarked to me, by one of our most intelligent and practical farmers, "that no farm (if it has a suitable soil) should be without lucerne, in the proportion of 1 acre (at the least) to every four horses."

1841. My growth of lucerne this year, in a field of 8 acres of sandy soil, with dry sandy loam for its subsoil, being the third year's growth (the seed having been sown 20 lbs. per acre in 1838 by Bennett's seed-engine, with a crop of barley), produced me in its first mowing this year (which commenced May 24th) six weeks' entire support for thirty horses, keeping them in good condition and in good health, with constant employment: the second mowing began July 3rd, fed me twenty horses in six weeks; and the third began Sept. 15th, supported thirty horses fourteen days. After which the autumnal feeding with sheep was equivalent in value to the expenses of cleaning, &c. in the previous spring, which was

effected by the extensive use of the Finlayson harrow, a process necessary every second or third year, if upon soils inclined to grass: the only manure used upon this crop has been soot, at about 30 bushels per acre, applied twice since the sowing in 1838. It would be unnecessary for me to offer any comment upon the practical utility of this valuable grass, further than by urging its cultivation to all; and merely to add, that in every case in which the land has been again returned to its ordinary culture of vegetable and corn produce, after having lain from eight to ten or twelve years in lucerne, it has invariably been more congenial to production.

*Alderton, near Woodbridge,
Feb. 28, 1842.*

Lucerne has been cultivated at Audley End for many years upon a limited scale, and I regret that no sufficiently accurate account of the crops has been kept to enable me to furnish the particulars. The result has, however, been very satisfactory, leaving no doubt that the profit of the cultivation of this plant has averaged for seven years 10*l.* per acre, after deducting rent and all other outgoings and expenses. The soil is a rich loam over gravel.—BRAYBROOKE.

XIX.—*Agriculture of the Netherlands.* Part II. By the Rev. W. L. RHAM.

THE necessity of a succession of different crops to ensure success is fully understood in the Netherlands, and especially in Flanders and in the provinces bordering upon France. The rotations which have been long established are not founded on any theory of vegetation, but the simple result of long experience and observation. It is gratifying to find how nearly they accord with what sound theory, founded on experiments in vegetation, has laid down as a rule, viz. that plants of different natural families should succeed each other as far as is practicable; and where any marked deviation occurs from this rule it is not difficult to explain the cause, if not to justify the exception. These rotations were evidently the result of gradual improvements in the mode of cropping suggested by the failures which an irregular system necessarily brings along with it. On the light soils the system of a fallow preceding two crops of grain never has had any influence on the succession, for there fallows are unknown; but the necessity of a good supply of manure and the want of natural meadows have made the cultivation of roots and green crops a matter of neces-

sity; and experience soon showed the advantage of those crops which allow of summer tillage for the eradication of weeds. In the first volume of this Journal will be found some account of a rotation which is strictly adhered to in the neighbourhood of Lilles, in French Flanders, and which need not be repeated here. The following, which are inserted in the *Outlines of Flemish Husbandry*, are taken from the work of Mr. Van Aelbrook, the only Fleming who has written fully on the agriculture of his country, and who may be considered as the patriarch of Flemish husbandry, to which he has directed his attention during the whole of his life, which is protracted considerably above fourscore years, in the full enjoyment of his faculties :—

No. I.

TABLE of ROTATIONS in a poor Sandy Soil.

First Year.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.
Flax and Carrots.	Rye and Turnips.	Rye and Turnips.	Buckwheat.	Carrots.	Potatoes.	Barley and Turnips.	Flax and Carrots.	Flax and Carrots.	Rye and Turnips.
			Oats.	Clover.	Barley and Turnips.	Potatoes.	Rye and Turnips.		
			Potatoes, Peas, and Carrots.	Oats and Rye.	Clover.	Rye or Barley and Turnips.	Ditto, Oats, and Potatoes.		
			Spurrey and Turnips.	Buckwheat.	Potatoes.	Oats.	Flax and Carrots.		
Flax.	Rye.	Clover.	Rye and Turnips.	Rye and Turnips.	Oats or Buckwheat.	Potatoes.	Rye and Turnips.	Flax.	Clover.
Flax and Clover.	Clover.	Oats, or Spurrey, or Peas.	Rye and Turnips.	Rye and Turnips.	Buckwheat, or Potatoes, or Carrots.	Carrots.	Rye and Turnips.	Rye and Turnips.	Flax.
						Barley and Turnips.	Oats.		
						Rye and Turnips.	Rye and Turnips.		

This table gives the usual rotations on the poorest sands, where it is in vain to attempt to raise wheat. The principal crops of grain are rye, barley, and buckwheat; flax is introduced as a necessary article for the domestic spinning and weaving, which occupies the labourers and servants in winter, when there is no work out of doors; but it only recurs once in seven or eight years. Rye and turnips recur frequently, and immediately after each other; that is, rye is sown in autumn and reaped early next summer, the stubble is ploughed before the rye is out of the

field; turnips are immediately sown, and watered with liquid manure, and these are gathered in time to manure and plough the land again for rye. The turnips are supposed to have sweetened the land; and the second crop of rye shows no symptom of weakness or disease. The ground, however, has not been cleared of root-weeds, although the turnips have been very carefully hand-weeded; the next crop therefore must be one which admits of good preparation and careful destruction of weeds, such as potatoes, peas, and carrots. Unless the peas be very carefully cultivated and gathered very early in a green state, it does not appear how the ground is to be cleaned so as to admit of a corn crop after it, viz. oats or rye again. In order to see how rye can be made to return so often, we must follow the mode of cultivation adopted. In the poor sands every crop, except buckwheat, has not only a considerable portion of stable manure ploughed in before the seed is sown, but also a quantity of rich liquid manure, consisting of cows' and horses' urine, or the emptyings of privies mixed with water. The process is thus described in the "Outlines :"—

"The stubble is well harrowed soon after harvest, in order to pull up the weeds and expose their roots to the sun. In the beginning of October from 10 to 15 tons per acre of good rotten dung are spread evenly over the land, and immediately ploughed in 6 inches deep: the land is ploughed in stitches or beds, varying from 6 to 12 feet wide according to the nature of the soil; the heavier soils are laid in the smallest stitches: liquid manure at the rate of 10 hogsheads per acre is then poured into the intervals between the stitches, by means of a water-cart, which delivers it regularly, the horse walking in the interval. The harrows are now drawn across the stitches. This brings a part of the fine soil into the intervals, and prevents the too rapid evaporation of the liquid manure. Six pecks of rye or of wheat, or 2 bushels of winter barley, are now sown evenly over the land. The manured soil in the intervals is first stirred by the plough going once up and down, as is done between rows of turnips in the Northumberland system, throwing the loose earth in a ridge in the middle. Men follow with shovels, and throw this earth over the seed, as is done with potatoes in lazy-beds in Ireland, and completely cover it. A roller is then passed over, if required; or, in very loose soils, men tread in the seed regularly with their feet as the gardeners do. The small extent of the farms allows of this garden culture, which in large occupations would be impracticable; but the principle is the same, whether executed by manual labour or machinery."

The deep stirring of the soil, and the fresh rich earth from the intervals spread over the seed, cannot fail to secure a vigorous vegetation. The turnips, although they are never eaten by sheep on the land, because they are more valuable for the cows, produce much liquid manure in the tank, and draw but little from the soil, they seem to have the power of counteracting the de-

teriorating effects of the rye; as, in rich loams, beans do after wheat, so that wheat and beans are raised alternately for a long course of years without any apparent diminution of the produce. There is no use in reasoning against facts; and whether this system agrees with our theories or contradicts them, it cannot be denied that, by means of effectual tillage and abundant manuring, the poor sands in Flanders are made to produce all the crops mentioned in the table of rotations. Rye comes four times in ten years, whereas all other crops have a much greater interval between them. A very large portion of manure of every kind, especially rape-cake dissolved in urine, is incorporated with the soil for several years in succession, to prepare for a good crop of flax; and it does not seem that there is any fear of reducing the fertility too much by taking exhausting crops during the time that this manure is accumulating in the form of humus. The great object is to impregnate the soil deeply and uniformly with organic matter, while it is kept free from weeds by careful hand-weeding and hoeing. The effect of liquid manure on poor loose sands, if not seen, would not be credited. If a portion of the unimproved original soil were produced and compared with that which has been many years in cultivation, it would be difficult to persuade a stranger, not acquainted with the system of gradual improvement, that the latter was originally as poor as the former. The organic matter diffused through it alters its nature entirely; from being porous and drying rapidly, it now retains moisture as long as good clay loams; from a loose texture, which could scarcely be made to adhere together when wetted and worked in the hands, it now readily dries in clods, which require some force of the fingers to pulverize them; and, when thoroughly moistened, almost admits of being moulded into any shape. This acquired property would be lost in a very short time, if the organic matter which is decomposed by the vegetation of the plants were not constantly replaced by the addition of manure, both liquid and solid. In loose sands the manure is chiefly cow-dung, mixed with very little straw, and that in a decomposed state; or composts formed of the heaviest earth which is to be found, with refuse vegetable and animal matter, repeatedly watered with tank-liquor, as we observed before. The quantity of manure put on the land when potatoes are to be planted is nearly double what would be thought a good dressing in most farms in England; and hence a very great portion of it is left behind in the soil, and enriches it for the next crop, which is either oats or flax, with clover or carrots as a secondary crop.

The sowing of carrots amongst a growing crop is peculiar to the Netherlands. If it were not for deep trenching and a thorough incorporation of organic matter with the soil to the depth

of 18 or 20 inches, this double crop could never succeed. The carrots come up very slowly, so that the flax keeps the upper hand. The most minute and industrious hand-weeding leaves the flax and carrots sole possessors of the soil. The carrots make no great progress till the flax is pulled; but as soon as this is done, and a good sprinkling of rich liquid has moistened the surface, and another weeding and thinning of the carrots, if it is required, has given them room to swell, they advance most rapidly, and in a couple of months the green tops of the carrots cover the ground, and show that they have good substantial roots. The white carrot which grows partly out of the ground, where it assumes a green colour, is generally preferred, when the soil is in good heart. This carrot has been successfully introduced in this country, from a small parcel of the seed sent to the author of this paper several years ago by the President of the Royal Agricultural Society at Brussels. It was first cultivated in the garden of the School of Industry established at Winkfield, in Berkshire, and the seed raised pure and unmixed. It is extensively cultivated in France, but the Belgian variety maintains its superiority. When sown amongst flax or barley the carrots never acquire half the size which they do when they occupy the ground alone; but as it is a subsidiary crop to the flax, the whole of it is clear profit, deducting only the expense of weeding and hoeing out.

The table does not exactly point out how much land is occupied by each crop, because this differs according to circumstances. There are three systems of rotation, all beginning with flax and ending with flax. The first and second have flax in the eighth and ninth year; in the last the flax only recurs in the tenth. This is to show how the rotation may vary when there is some deficiency in manure, or the land has not been kept in so clean a state as may be desirable, and always should be, when flax is sown. When the land is not quite clean the flax is sown alone, in order to allow of more frequent weeding; but when very clean and in high condition clover or carrots may be sown in the flax after it has been once well weeded.

Spurrey is a crop cut green for the cows, and consequently not so exhausting as rye or oats; it is sown when manure is not abundant; for in the light sands every grain crop has a portion of manure, solid and liquid. When manure is abundant potatoes are raised in considerable quantities; when it is less so, a portion of the land bears buckwheat, which requires no manure. Whenever rye is sown it is presumed that the land is in good heart; and to have good flax it must not only have abundant remains of former manurings, but it must also be very free from weeds and stirred to a great depth. On the more fertile sands or sandy loams the following arrangement of crops is not uncommon. The farm

being divided into eleven fields or portions, there are two in potatoes; two in wheat, with stubble turnips after it; two oats with clover; two clover; two rye and turnips; and one in artificial grass:—

No. II.

TABLE of ROTATIONS for the richest kind of Light Soil.

First Year.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.
Flax and *Clover, or Carrots.	Wheat.	Rye and Turnips.	Rye or Barley, and Turnips.	Potatoes.	Wheat.	Rye and Turnips.	Flax.	Clover.	
			Potatoes.	Wheat.	Rye or Barley, and Turnips.	Oats.	Flax and Carrots.	Rye.	Clover.
	Oats.	Rye and Carrots, or Barley and Turnips.	Potatoes.	Wheat.	Rye and Turnips.	Barley and Turnips, or Oats.	Flax.	Clover.	
	Barley and Turnips.	Rye and Carrots.	Potatoes.	Wheat.	Rye and Turnips.	Flax and Carrots.	Oats.	Clover.	

* If clover is sown with the flax it is cut in the second year, and another year is added to the rotation: but it is more usual to sow carrots with the flax, and sow oats or barley the second year.

The rotation in Table II. is calculated for a tolerably rich light loam, and it is only by the application of a very considerable portion of manure that this rotation can be adopted. Here the flax recurs sooner than in the first table. The first rotation in the table includes one crop of flax, two of wheat, two of rye, and one of potatoes, in seven years. Wheat generally follows potatoes, and rye always comes after wheat. This again does not accord with modern notions of agriculture in England. As a specimen of the quantity of manure used in a rotation on a good compact loam, we will give one from Mr. Radcliffe's report of the agriculture of Flanders:—

1. Potatoes . . . 20 tons of dung per acre.
2. Wheat . . . 3½ tons of dung, and 50 barrels of cows' urine.
3. Flax . . . 12 tons of dung, 50 barrels of urine, and 5 cwt. of rape-cake.
4. Clover . . . 20 bushels of wood-ashes (top dressing).
5. Rye . . . 8 tons of dung, and 50 barrels of urine.
6. Oats . . . 50 barrels of urine.
7. Buckwheat . . No manure.

Here then are 43 tons of dung, 200 barrels of urine, 5 cwt. of

rape-cake, and 20 bushels of wood-ashes, on six acres of land, and only one crop of buckwheat taken before the same quantity is laid on again. This land is of the best quality, situated near Alost, where very good hops are grown.

In England, after manuring with 20 tons of dung for a crop of potatoes, it would not be thought requisite to manure the land again for wheat, and this is probably one of the reasons why wheat thrives better after potatoes in the Netherlands than it does in England or Scotland.

On a farm near Courtray, consisting of a little more than 100 imperial acres, a rotation was strictly adhered to which appears to be very profitable. The farm is all arable, and divided into six portions:—1 is half in flax and half in colza; 2. wheat; 3. rye and turnips; 4. oats (five-sixths of which with clover-seed, one-sixth left for potatoes and carrots); 5. clover and roots; 6. two-thirds wheat, and one-third beans. This rotation could not be continued long if the manure were not very abundant. Flax and colza recur only once in twelve years, wheat nearly every third year, rye and turnips and oats once in six years, clover once in six years; potatoes and carrots only in very small quantities, the soil being a stiffish loam. Experience proved to the farmer that every deviation of any consequence from this course diminished his profit. The land was abundantly manured, and all the crops were in the greatest perfection when we visited it. This shows that, where manure can be had in abundance, the rule, which otherwise is advantageous, of not taking two white grain crops in succession, may be deviated from without much danger of exhausting the land, especially in rich loams. Wheat may always, in this case, be sown every third year; but clover, flax, and colza require longer intervals. The principal manure consists of the emptyings of privies and other rich substances from the neighbouring town, which, with the sweepings of the streets and the ashes, make a very considerable addition to the manure made on the farm. It will rather surprise the English farmer to be informed that on such a farm 30 milch cows and heifers were constantly kept, and that two paddocks of a few acres each, for the cows to take exercise in about two hours each day, were the only part of the farm not under the plough. The cows have oil-cake, beans, clover, and roots, with cut straw. The clover is nearly all consumed in a green state. The urine-tank is most capacious, being 20 feet wide, 7 feet deep, and 50 feet long, divided by partitions. The cow-house is washed out twice a-day, there being usually a pump in the middle of it with a stone cistern under it, in which bean-meal is constantly kept mixed with the water which the cows drink. This greatly increases the milk.

No. III.

TABLE of ROTATIONS for a good Strong Loam.

First Year.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.
Flax.		Oats.	Carrots, or Barley and Turnips.	Wheat.	Rye and Turnips.	Potatoes.	Wheat.	Rye and Turnips.	Flax.
				Beans.	Wheat.	Rye and Turnips.	Potatoes.	Rape and Carrots.	Flax.
	Clover.	Barley and Turnips.	Rape and Carrots, or Beans.	Wheat.	Rye and Turnips.	Potatoes.	<div> <div>Rye and Turnips.</div> <div>Oats or Flax.</div> </div>	<div> <div>Oats or Flax.</div> <div>Rye or Barley, and Turnips.</div> </div>	Flax.
							Wheat.		
	Wheat.	Barley.	Beans.	Wheat.	Rye and Turnips.	Potatoes.	Rape and Turnips.	Oats or Flax.	
		Rye and Turnips.	Oats and Clover, or Potatoes.	Clover, Rape, and Turnips.	Wheat.	Rye and Turnips.	Flax.		
	Rape and Turnips.	Wheat.	Rye and Turnips.	Oats.	Clover.	Wheat.	Rye or Barley, and Turnips.	Oats or Flax.	

This table of rotations for good rich loams includes a great variety of crops, and introduces beans and rape, which are not well suited to light soils. Rye, being used mixed with wheat for the labourers' bread, forms a part of every rotation; and it may be remarked that this crop, which in England is almost invariably consumed in a green state by cattle and sheep in the spring, or the early part of summer, is seldom sown for this purpose in the Netherlands; but in its stead oats and winter barley are sown to be consumed in a green state. Rye, however, when sown very early in summer so as to cover the ground well before winter, may be fed down by sheep about November, and produces a greater quantity of early green food in spring than any other kind of grain. Rape and beans are both good crops to precede wheat; but they must be well manured. The cultivation of beans is not so well managed in the Netherlands as in the rich soils in England.

Drilling and dibbling are very seldom resorted to for this crop. They are sometimes set in rows by the hoe, and then admit of hoeing in the intervals, by which the crop is much increased, and the land kept clean; but, in general, they are sown broadcast,

and, unless the crop be very abundant, they encourage a variety of weeds, which grow between the plants, and shed their seeds before the beans are fit to be harvested. In this third table carrots are introduced in a heavy soil. It is a general opinion that carrots only grow advantageously in loose sandy soils; but this is a mistake: carrots require a soil pulverised to a considerable depth, to allow them to penetrate deep with their long roots; but they are finer and larger in a good loam which has been well stirred than in a sand; and the white Belgian carrot, especially, grows very large in a good heavy loam, provided it can freely shoot downwards. The same may be said of potatoes, which grow abundantly in heavy loams, if they have been well drained.

The quantity of seed on a given extent of land in the Netherlands is much smaller than it is usually in England. This is owing to the greater attention paid to prepare the land for receiving the seed. The greater quantity of manure, especially the liquid portion, hastens the first vegetation. The surface is brought to a finer tilth, by repeated harrowing with light wooden harrows, which are sometimes drawn by a man, and also by the traineau of which a description was given in the first part of this paper. The seed is frequently trodden in by the feet of men and women, so that none of it is lost by the depredation of birds, or dried up by being exposed to the sun's rays, when it has just begun to vegetate. A small layer of mould is frequently shovelled over the seed from the intervals between the beds or stitches, after it has been well soaked with liquid manure a few days before. All this secures the germination of the seed, and accelerates the growth of the plants.

“When wheat or winter barley succeed potatoes, as is generally the case, the ground is not ploughed, but only harrowed across; the stitches are marked out by the plough, and the earth in the intervals is spread over the seed. About a bushel and a half is the greatest quantity of seed sown per acre. The average is five pecks. After rape, which is reaped early, there is time for a bastard fallow, which is not lost sight of. The land is ploughed, cross-ploughed, and laid in stitches, and then the wheat is sown in the same manner as before described. It must however be observed, that, as potatoes and rape are very highly manured, no additional manure is put on for the wheat; but should its appearance in spring not be vigorous, the urine-tank is resorted to to supply the deficiency.

“Great attention is paid to the choice of seed; the wheat is generally pickled or steeped in salt water, and dried by sifting lime over it before it is sown. Some scientific farmers use vitriol, arsenic, and various preparations, to prevent smut; but urine, salt, and lime are the most common, and seem to answer the purpose completely. The other grains are not usually prepared by steeping, but sown in their natural state.

“There are several varieties of rye; but none appears to possess any

decided superiority: of wheat there are many sorts, white and red: the white wheat which grows at Kalken, not far from Ghent, is in great repute for the fineness of its flour. It seems to degenerate in every other soil. We have seen a red wheat with a white chaff in one or two places, which bears a very great resemblance to some of the wheats lately brought into notice in England under various names. The common sorts, both white and red, appear full, and the straw strong and healthy: careful cultivation, no doubt, increases the produce and lessens the casualties from disease or climate. A mixture of wheat and rye is sometimes sown, which is called *meslin* in Yorkshire, and *meteil* in Flanders. It is asserted that, in a certain proportion, the two grains produce more when sown together than they do if each be sown separately. Those who defend the practice maintain that, if the season does not suit wheat, it suits rye, and that between the one and the other a crop is secured. The adversaries assert that rye and wheat ripen at different times, and that the wheat will be reaped too green, or the rye will be over-ripe and shed. But as pure wheaten-bread comes more and more generally into use, meslin is in less demand, and can only be used in the farmer's family. Wheat and rye separately are more readily disposed of in the market, and this will be sufficient to decide the question; accordingly, meslin is but sparingly sown; where the land will bear it, wheat is sown instead; where it suits rye better, the latter is preferred.

“Barley is considered as a grain of much importance in a country where the vine does not thrive, and where beer is the principal beverage. The variety preferred is that which is sown, like wheat, in autumn, and is called winter barley. In the rich soils of the polders, especially those which contain much silicious and calcareous sand in their composition, extraordinary crops of barley are sometimes raised, as much as ten quarters per acre, weighing from 50 to 56 lbs. per bushel, and this induces the farmers frequently to sow this grain twice in succession, without any manure. The favourite sorts are called *Escourgeon* and *Sucrion*. They are sown in autumn and reaped in July. Spring barley is sown occasionally, but produces a smaller return, and the grain is lighter.

“Oats are frequently sown after clover, and sometimes after rye or potatoes, as suits the rotation. It is a grain that thrives in almost any soil, with a small proportion of manure, and, when the land is enriched, gives a large return. The preparation for oats in Flanders begins by spreading dung over the clover-ley, but in a smaller quantity than for barley. This is ploughed in before winter with a shallow furrow, which is laid over flat to accelerate the decomposition of the roots of the clover. Sheep-dung is thought peculiarly good for this purpose. The land is ploughed deep in spring, not to bring the dung again to the surface, but to turn a coat of earth over it. Liquid manure is sometimes spread over the surface before the seed is sown, but not always. The crop seldom fails to give from 6 to 9 quarters per acre from 2 bushels sown, which is not more than half the seed usually sown in England.”

The Friesland oats are well known in England as of a very good quality for brewing, and great crops of them are raised in

the rich alluvial soils of Holland; but here there is not that careful cultivation which is found in the poor sands of Flanders. Rape, wheat, beans, and oats often follow one another, and the land is then regularly fallowed, and a large dressing of manure is given for another exhausting course.

Turnips are seldom sown in the Netherlands otherwise than as a second crop after rye or winter barley. This root was, however, cultivated in the Low Countries for more than a century before it found its way into British husbandry as a regularly returning crop. The circumstance of the early maturity of rye on light soils, no doubt, suggested the idea of raising another crop before winter; and turnips, which require to be sown late, naturally appeared well suited for this purpose. No time, however, was to be lost, for a few days' delay in sowing the seed may make the difference of a good crop or an entire failure. Those kinds of turnips which grew most rapidly were consequently preferred, without great regard to the size which some others might attain when they had sufficient time to grow to perfection. Large turnips are not thought so nutritious as the smaller, and 4 or 5 inches in diameter is considered as a very good size for a turnip. The rye is no sooner cut and tied into sheaves than the land is ploughed, or the stubble cut with a heavy hoe, which stirs the soil 2 or 3 inches deep. The roots of the rye are raked off, and either burned or carried into the yard to be converted into manure in the *croupissoir* mentioned before. The surface is well soaked with liquid manure, and the turnip-seed is sown broadcast, rather thick, and harrowed in. In the sandy soils the roller is drawn over, and makes all the surface level and compact. A very few days are required to bring the plants up, and there are seldom any complaints of the ravages of the fly. When the rough leaf expands, the crop is hoed or more frequently weeded and thinned by hand. The turnips are left 3 or 4 inches apart, and when they have acquired the size of walnuts or small apples, they are again thinned out, the thinnings being carried to the house to be mixed with the food of the cows. In three months, if the season has not been very hot and dry, there is a very decent crop of turnips, which are pulled and washed, and the tops cut off. The green part is given immediately to the cows and pigs, and the bulbs are stored in the root-cellar, a spacious vault partly under ground, which is a necessary appendage to the buildings of every farm-yard. Thus the land is clean and ready to apply a good dressing of manure, which being ploughed in, the second crop of rye is sown without any fear of its not succeeding.

There are several causes which would prevent this system from being successfully adopted in England. The rye and barley harvest are not so early; and before the land can be prepared for

sowing turnips the dry weather sets in, and there is little chance of the turnips coming up so rapidly as to escape the fly; and, what is a very material circumstance, few farms have urine-tanks, or stall-fed cattle to fill them, if they had. When we have rye fed off or cut green for the horses in May, we can have a very good crop of potatoes or turnips after it, especially if the land has been well stirred and manured for the rye in the preceding autumn.

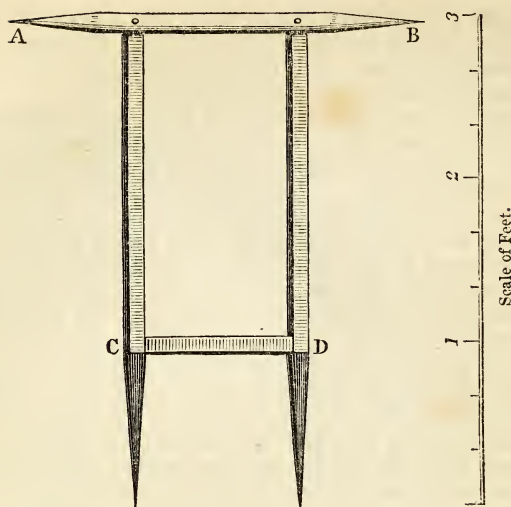
“There is another root the cultivation of which is often very profitable, although of comparatively small use on the farm; this is chicory, of which the dried roots are roasted and used instead of coffee. A considerable commerce in this root has sprung up lately, which has caused a duty of 20*l.* per ton to be laid on its importation into Britain. It is the same plant which Arthur Young so strongly recommended for its leaves for cattle and sheep; but it has not been found to answer the expectation in this point of view. The root contains a strong bitter, which may be extracted by infusion; it is also used in the brewing of beer to save hops: it is wholesome, and if it does not impart an unpleasant taste to the beer, there can be no objection to its use. At all events the cultivation of it, whether for beer or coffee, is a part of Flemish agriculture, and deserves to be noticed. The seed is sown in the end of March or beginning of April; it is treated exactly as the carrot when sown alone: the ground should be mellow and deep, rather heavy than light, and ploughed or trenched to a good depth. It is sown broadcast in Flanders, as everything else is; but it would be much better if it were sown in rows 18 inches apart. The leaves may be given to sheep or pigs; but they give a bad taste to the milk of the cows which eat them. The roots are taken up in September, and are then of the size of a small carrot: they are cut into pieces and dried in a kiln; in that state they are exported: the price varies much, according to produce and demand. It is not an object of general cultivation, but only by particular persons and in particular soils: the market is overstocked at one time, and a great demand exists at another. Such a produce can never enter into a regular course, but may be raised as circumstances may afford a prospect of sale and profit.”

The oily seeds are extensively cultivated in the Netherlands, especially the colza or rape—*Brassica campestris* and *Brassica napus*, which are often confounded in England under the general name of rape. The colza is a plant more nearly allied to the cabbage, of which it is a variety. It is sown in summer and planted out before winter, and the next year it flowers and produces seed. The rape or *Brassica napus* is a quicker-growing plant, usually sown in spring, and ripening its seeds the same year. The produce of the former is greater and more valuable than of the latter. The cultivation of the colza in the Netherlands is worthy of notice, for, next to flax, it is considered as the most profitable crop, being a very good preparation for wheat to follow it.

“The colza is a plant which requires a good and rather strong soil, as well as a careful cultivation. In Flanders it enters into the regular rotations on all good heavy loams, and is thought an excellent preparation for wheat, as may be well supposed, when it is considered how the soil is tilled for this plant, how much it is manured, and what care is taken to keep it clear from weeds.

“In the polders, where fallows are still occasionally resorted to, colza often supplies their place. It is sown broad-cast in July, as turnips are. The ground is ploughed in autumn and in spring, and again a short time before the seed is sown, and well manured with farm-yard dung. The seed is sown very thin and harrowed in: as the plants come up they are weeded and thinned out, so as to leave them 9 inches or a foot apart. Before winter they have acquired a considerable size, and the stems have had the earth drawn up to them: thus they remain all winter without injury from the frost: in spring they are weeded again and the earth gathered round each plant, which ensures a vigorous growth of the seed-stem. After flowering in April and May the seed-pods fill, and begin to get ripe in June or July: care is taken to cut the crop before the pods are fully ripe, or they would shed a great part of the seed. Dry warm weather suits this best; as then the stems may be laid on the ground for a short time to dry, and the seed may be immediately thrashed out on a cloth in the field, which is soon accomplished if the weather permits. The crop is then safe, and is stored in a dry and airy granary till it is sent to be crushed.

“But this is not the mode in which colza is cultivated in the other parts of Flanders, as there fallows are unknown, and the land is never left idle. The seed is sown in a bed of good earth, prepared on purpose to raise plants to set out after harvest, when the land has already yielded a profitable crop. These plants are taken up carefully in October. When the stubble has been cleared of weeds by the harrows, the land is well manured, ploughed to a good depth, and laid in stitches: the plants are then brought in baskets to the field. A man, with a wide spade made on purpose, opens a gap in the soil, by planting in the spade vertically, as far as the blade will go, and then pressing the handle towards his body; a woman or child with a basket or bundle of plants immediately sets one in each corner, and the spade handle being replaced in a perpendicular position, the earth falls back upon the two plants. The man, when he has drawn out the spade, puts his foot between the two plants, and thus presses the earth against their roots. The whole of this operation is performed in far less time than we have taken to describe it; in fact, practice gives such dexterity, that a double row of plants is set in a very short time all along the bed: the next double row, which is set in returning, is eighteen inches distant from the first, and the plants are placed so as to alternate with those in the first row. Instead of a spade, some use an instrument called a *plantoir*, which makes two holes at once, and is pushed in with the foot pressing on the cross bar C D (see fig.), while the handle A B is held in both hands. In this case a plant is set in each hole by a person following the dibbler, and the earth is pressed to it by the foot. Whichever way the plants are put in, some will always fail, and a supply is kept in the seed-bed to



replace them at any time in autumn or spring. The intervals between the rows are hoed and weeded, and even sometimes dug with the spade, which is a good practice; and the plants are treated as cabbages are in a garden. In November, before the frost sets in, the intervals between the stitches are dug out, and the earth placed in small heaps between the plants, both to receive the mellowing influence of the frost, and to protect them against very cold winds, which, when there is no snow, sometimes injure the young colza. In spring these heaps are levelled, and the earth is raised around the stems. They cannot fail to grow and shoot out strong seed-stems and succulent leaves. These leaves are much relished by cattle, and this sometimes induces the small farmer to gather a portion of them for his cows, at a time when fodder is scarce; but he pays dear for this supply, by the diminution of the seed, which is abundant in proportion to the luxuriance of the leaves on the stem at the time of flowering.

“When the colza is cut, it is thrashed, as described before, unless the weather be very unfavourable; in that case it is dried, as well as circumstances permit, without much handling: it is then laid in layers with dry straw, and stacked in the field, or carried to the barn. This plan is, however, seldom resorted to in Flanders: the season in general permitting its being housed in a dry state, if not thrashed in the field.

“To save time and trouble the plants of colza are sometimes put in with the plough, being set in the furrows, as we have described in planting potatoes; with this difference, that the plants are set upright, or rather slanting a little against the furrow-slice last turned up, and the return of the plough covers the roots, leaving the crown above ground. A man goes along the furrow, and with his foot presses against each plant to settle the earth around it. This method is not so much practised in Flanders as it is in other parts of Belgium, where the extent of

farms is much greater, and where so much labour cannot well be spared for each crop. It is a less perfect method, and the plants do not take root so certainly, or grow so well as by the other. An acre of good colza produces on an average thirty bushels of seed."

"The poppy is cultivated in Flanders for its seed, from which an excellent oil is expressed, little inferior to that of olives. There is a white variety of the poppy and a purple: the first produces the best oil, the latter the greatest quantity. A rich loamy soil is the best for this plant, as it is for most others which bear oily seeds: and it is prepared in the same manner as for any other spring crop which requires a rich deep soil. Two ounces of seed is an ample allowance for an acre of land, which is ploughed in stitches, and harrowed before the seed is sown: the earth out of the intervals being thrown over the seed, the harrows reversed are drawn over it. In May the plants are thinned to a foot distance each way; for each throws out many stems. In August the seed is ripe, and it is gathered in a manner which will appear tedious, but which is effectual to obtain all the seed in perfection. When some of the heads begin to dry, and the openings through which the seed sheds appear under the crown, men and women go along the rows of poppies, and shake every head in succession over a basket or box hung on the left arm, without breaking the stems: all the ripe seeds which are loose in the head, drop out, and in time the basket is filled, and the seed is put together in sacks. A few days after the same operation is repeated, after which the stalks are pulled up and tied in bundles, which are placed upright in the field, that the remaining seeds may ripen: they are then finally shaken out, and the whole produce added together may amount to twenty bushels per acre. The heads and stalks are of little use, and are either burnt on the ground for the sake of the ashes, or are carried home to help to heat the copper in which the food is boiled for the cows, as we shall see hereafter. When the poppy-heads are wanted for the druggists, they are cut off, with a portion of the stalk, before the seed is ripe, and when there are no apertures under the crown. They are tied together, and hung in a shady and dry place to lose their moisture. In this state they contain the soporific juice, for which they are used in fomentations, &c. The cultivation of the poppy for this purpose is chiefly in gardens."

Flax, being one of the most important agricultural products of the Netherlands, deserves especial notice. Flanders is the country where the cultivation of it is best understood, and, as a detailed account has been given in the 'Outlines,' we shall extract from this work the most important particulars:—

"The soil most proper for this plant, if there is a choice, is a deep, rich, friable loam, neither too dry in summer nor wet in winter; in short, the best and deepest soil that can be found: but as this is scarcely ever to be obtained to any great extent, art and labour must supply the deficiency of nature; and trenching, working, and manuring must create a deep soil and enrich it. A porous subsoil, or one that is well drained, is essential. In a course, or rotation, in which flax enters as a principal crop, the whole management of the land should have a reference

to the flax to be raised. In the three tables of rotations which we have given on the authority of Mr. Van Aelbroek, it may be observed that each begins with flax and ends with flax; and there is no doubt that the arrangement of the crops is much influenced by the preparation of the soil required to bear a good crop of flax at the end of the course. For this purpose a surplus of tillage and manure is given to each crop, so that the soil is deepened and ameliorated at each successive step, and is brought to as perfect a state as it will admit of by the time the turn comes to sow flax. This may remove the surprise which is naturally excited by the amount of tillage and manure given for each crop, which appears, at first sight, far greater than can be required. The quantity of liquid manure poured over the light lands year after year, cannot fail to make them rich, and the frequent trenching with the spade, must, in the end, transform the whole soil, to a considerable depth, into a compost of rich vegetable and animal matter intimately mixed with the natural earths. It is, in fact, an accumulation of humus, which is the best preparation to ensure a good crop of flax: it is not, therefore, to the immediate preparation of the soil for the flax that its abundance or good quality is to be chiefly ascribed, but to a gradual system of amelioration, which has brought the soil into the high condition required for this plant."

"The crops which immediately precede flax in light soils are barley, or rye, with turnips after them the same year. In this case these crops are more highly manured than usual, and the turnips have a double quantity of liquid manure. About Christmas, the turnips being taken off, the land is ploughed into high ridges, and the intervals dug out: it remains in that state secure from wet and exposed to the winter's frost. As soon in spring as the weather permits, the land is again ploughed and well harrowed, to let the seeds of annual weeds vegetate. A month after another deep ploughing and harrowing are given to bring the land into good tilth and clean it well. Peat-ashes are now put on at the rate of 30 bushels to the acre, and these are spread and harrowed in; a few days after 10 hogsheads of strong liquid manure—the emptyings of privies is preferred—is regularly poured over; and thus it is left for a week or ten days that the manure may soak in. The seed is then sown: the quantity varies, but is always very abundant—160 lbs. are generally sown on an acre. The seed is slightly covered by a bush-harrow or the traineau drawn over the land: more than half an inch of earth over it would prevent its vegetating. Cloudy or showery weather is chosen for sowing it, as a very hot and dry air might also prevent its rising. The best seed is imported from Riga. The first crop of seed raised from the Riga seed is sometimes used, but it is supposed to degenerate fast; and the home-raised seed is said to produce coarse branched flax: this, however, is maintained by others to be a mere prejudice; and it is recommended to sow a spot thinly, and give the plants room to grow and perfect their seed. The flax of these plants will be much inferior, but the seed will be good and plump, and equal to the Riga seed for sowing. The question arises still which is the cheapest method, to raise seed thus, or to import it; this is a matter of simple calculation, and we must leave the flax-growers to decide it."

"The method of steeping is the same at whatever time it be done, and

the following is the common process:—A piece of water over which alders grow is chosen in preference, as the leaves of that tree steeped in the water give the flax a peculiar tint, which is thought desirable; or if such a place is not at hand, alder-leaves are sometimes tied up in the bundles of flax. It is thought that the alder-leaves also drive away insects, which injure the fibres of the flax while steeping. The best and most experienced steepers, however, disregard these notions, and prefer the clear soft water of the river Lys, which they confine in long ponds made for the purpose along the side of the river, of such a depth that the flax may stand nearly upright in them without touching the bottom: this requires a depth of 5 feet or more. If they cannot be made so deep, the flax must be placed in a slanting position in the water, the root-end lowermost, and the upper end a little under the surface of the water. It is kept in this position by means of mats spread over it; and poles with stones placed on them keep the mats down and the whole under water. If the steeping takes place in August the fibres will be sufficiently loosened from the woody parts of the stem in a week. In October it will take double that time, more or less according to the temperature: the warmer the air is the sooner the flax will be steeped. In May it takes somewhat less time than in October; and the flax steeped then comes out of a lighter colour than that which is steeped while green.

“Some steepers tie the bundles together in pairs, the root-end of one to the seed-end of the other, so that half the flax leans upwards in the water and half downwards: but there seems no good reason for this practice, for, as the root end is sooner steeped than the upper, it will be unequally steeped, even if the flax be laid horizontally in the water, which is not thought so good as placing it vertically or nearly so. But as these men have great experience in the process, we must hesitate before we blame a practice of which we do not immediately see the advantage. Those who steep the flax in the Lys itself collect it in thick bundles nearly a foot in diameter, and somewhat longer than the flax, by laying several small bundles together, as described above. In these large bundles the roots project at each end and the tops are inside: they are tied round very tight in two places, about 6 inches from each end: they are then placed upright and closely packed in a cage, or open frame, made of wood and laths, 10 feet square and 4 feet deep: boards loaded with stones are placed over the top so as to sink the whole a few inches below the water of the river. Thus the water runs over and under the frame, and is continually changed: the consequence of this is that the flax becomes of a clean white colour, without the usual bluish tint, and is therefore more valuable. The time of steeping is somewhat longer than in stagnant water. It is pretended by those who do not adopt this method that there is a considerable loss in the weight of flax steeped in this way, which counterbalances the superior value. This is however not clearly proved, and the quantity of flax which is brought from a great distance to be thus steeped is a presumptive proof that this method is, on the whole, the most profitable and the best.

“The flax is frequently examined when it is nearly steeped enough: if it be left a few hours too long in the water, the quality is injured; and if it be taken out too soon, the whole fibre will not be detached, but will

break in the scutching. As soon as the fibres separate from the woody part the whole length of the plant, it is immediately taken out of the water, the bundles are untied, and the flax is spread out to dry on a piece of short grass, the place having been previously well swept, that no earth or dirt may be on it. In rainy weather this process is deferred; as rain would now injure the flax materially. It remains on the grass ten or twelve days, and is frequently turned over during that time. It is then housed, and in the course of the winter it is scutched and heckled, operations which, not being necessarily connected with agriculture, need not be described here."

Hemp is also an important product, and a considerable quantity is raised in the Netherlands.

"The soil on which hemp is intended to be sown is ploughed in autumn and again in spring. In the middle of May it is manured with 15 tons of good rotten dung, which is immediately ploughed in, unless the land had been manured in autumn, which is the better practice, as then the dung is already in a decomposed state at the spring ploughing. In some small farms the hemp-land is trenched and prepared with the spade, and it amply repays the additional expense. In either case the liquid manure is not omitted, especially if *vulanges* can be procured: five tubs of this last, each as much as a horse can draw on the land, are considered as good a dressing as 15 hogsheads of the common tank liquor, which is chiefly cows' urine. This manure is allowed to sink into the soil for three or four days; the land is then harrowed, and about half a bushel of hemp-seed is sown per acre. The seed should be heavy, shining, and dark-coloured, and of the preceding crop: in three or four days the plants make their appearance, and soon after this they are carefully weeded and thinned out by hand. In very good soils, and where strong hemp is required, the plants are left 6 inches from each other. The strongest plants are pulled up in preference, as the male plants, which produce no seed, appear first. The names of male and female, as applied to the plants of hemp by botanists, are usually inverted by the hemp-growers. They call that which produces the seed the male plant, and that which is barren the female. These names were no doubt used before the sexual system was well understood; but we shall call that the female which bears the seed. The male plants arrive first at maturity, at the time when the flower sheds the pollen which impregnates the female. They should then be gathered, as they would wither and become useless if left till the seed was ripe on the female plants. This taking out the male plants does good to those which remain; and in order that this may be done without breaking the females, the seed should be sown in narrow beds with paths between them. From this circumstance arises a practice of sowing hemp in a border all round a garden or potato-ground, or in rows, with potatoes between them."

"The produce of an acre of hemp in Flanders is about 350 lbs. of hemp, and from 30 to 35 bushels of seed, if the soil is good and well cultivated. It is not usual to sow hemp repeatedly in the same ground, as is done in many other countries, and also in parts of England, where a hemp-land is a name given to some enclosure near the farm-house,

which from time immemorial is the only spot where hemp is ever sown. The Flemish farmers have no hemp-lands; and they seldom sow this crop again in the same spot in less than eight or ten years. Hemp requires so much care and manure, that it is not a favourite crop: it clears the land from weeds, and is a good preparation for wheat; but flax is upon the whole more profitable, and therefore preferred.

“When the hemp has been steeped and dried, the fibres are separated from the wood by hand, or by a mill which crushes the woody part. This mill consists of a stone of a conical shape revolving on another circular stone laid horizontally, as in a cider-mill; the wood is thus broken, and afterwards easily separated from the fibre by beating and combing; but it is more commonly separated by hand, and the hemp thus treated is preferred. It is an easy employment for old people and children, by the winter’s fire, or in a summer’s evening; but it is too tedious to answer on a large scale.”

The mode in which cows are fed in Flanders, where they are invariably kept in the stable, and fed chiefly on the produce of arable land, is worthy of notice. In summer their chief food is clover, vetches, or barley cut green. In winter they are fed principally upon roots, such as carrots, turnips, and potatoes.

“These roots are chopped up together in a tub, and some bean-meal, rye-meal, or buckwheat-meal, is added: boiling water is poured over this and allowed to cool; or the whole is boiled together in a copper, when fuel is not too scarce. Of this mixture, which they call *brassin*, two pailsfull are given milk-warm, morning and evening, to each cow, and this is their food during the whole winter with a little wheat or barley straw. Hay is only given in a few districts, where the pastures are extensive, as about Furnes and Dixmude, but never in that unbounded quantity in which the cows eat it in England. Very little hay is made in any other district, and that only clover-hay, which is reserved for the horses when they work hard. Near the towns or large villages, where there are brewers, grains are added to the other ingredients of the *brassin*, and they greatly increase the milk.”

“After comparing the accounts given in a variety of places and situations of the average quantity of milk which a cow gives when fed in the stall, the result is, that it greatly exceeds that of our best dairy-farms, and the quantity of butter made from a given quantity of milk is also greater; an ordinary cow fed on young clover will give at three milkings, for the first three months after calving, from fifteen to eighteen quarts per day, which will produce $1\frac{1}{4}$ lb. of butter, that is, nearly 9 lbs. of butter per week. Where the number of cows is great, the average is much less, because, when there are only two or three cows, a deficiency in one of them is immediately noticed; the cow is got rid of, and a better one purchased. In a great number, there are always a few inferior cows, and a lower average is the consequence.”

“The cattle are kept on *brassin* and cut straw till May, when they are turned into the pastures, if there are any. But in all the upland farms, where the land is mostly arable, the food is cut for them and carried into the stalls. This consists of winter barley, or vetches, and

clover, chiefly the latter. At first, when the clover is very young, it is given sparingly, and, if all the turnips are consumed, boiled potatoes with a little hay are considered as a useful corrective; for clover, given injudiciously, causes the cows to heave. By the time the clover is in bloom it is their only food. Clover is not supposed to give the milk or butter any bad taste, as many think in England; although nothing gives so fine and rich a flavour as natural meadows. The butter made when the cows eat clover does not keep so well when salted; but there is so great a demand for it in the numerous towns and villages, that there never is any difficulty in disposing of it in a fresh state, that is, moderately salted; for as soon as the butter is made, a considerable portion of salt is always added."

In some parts of the Netherlands, as in Holland, the soil is better calculated for meadows than arable land, being low and flat, and necessarily intersected with many canals and ditches, in which the water stands very nearly on a level with the surface, and in some cases above it, being kept from overflowing the land by dykes of earth. In these meadows, especially in North Holland and Friesland, a very fine breed of milch cows and oxen is fed. The quantity of butter made for exportation, and its value in foreign markets, prove that the operations of the dairy are well conducted. The rich soil, no doubt, gives a good quality to the butter; but this is not the only cause of its superiority. The extraordinary cleanliness of every part of a dairy, and the constant and abundant use of water, the bright polish of the utensils wherever there is any metal, and the whiteness of the wood of the pails and churns, show the unremitting attention of the dairywoman. But the cleanliness is not confined to the place where the milk is kept. The stables, the cows, and even the litter, are kept so clean that it is a pleasure to walk through them; and the family often make one end of the cow-house their usual sitting-room, having a fireplace at one end, and always at least one comfortable bed for a labourer or servant, who always sleeps in the cow-house.

The arrangement of a Dutch dairy is well known, and has been copied wherever any pleasure is taken in having fine and clean cows. It is the same in Holstein, from which much good butter is also exported, and where a dairy establishment is called a *Hollanderey*, which shows its origin.

The building is generally like a large barn, with a roof coming to within 7 or 8 feet of the ground, sometimes tiled or slated, but more often thatched with reeds, which make it warm in winter. Through the middle, from end to end, is a space 10 or 12 feet broad, paved with hard bricks, which are always kept washed and swept clean. The heads of the cows are placed towards this middle space, from which all their food is given to them, sometimes in a shallow trough, made of bricks, level with the ground,

and sometimes a little raised, but always with a gentle fall from end to end, to allow of sweeping and washing, which is a daily operation, if not repeated after each time of feeding. As straw is scarce, the cows lie on smooth bricks laid sloping, and slightly hollow in the middle; and their beds, if we may so call them, are made of such a length that when the cows stand their tails hang over a gutter to receive the dung and urine. The cleanliness is carried to such a degree that in many cow-houses there are pulleys and lines over them with a weight at one end, the other being fastened to the end of the tail of a cow to keep it up, and prevent its dipping into the gutter behind. No sooner has a cow voided her dung or urine than the servant sweeps the gutter with a broom, and the dung falls into a recess or cesspool which communicates with a tank or reservoir. The gutter is frequently washed out, and the water, running also into the reservoir, serves to dilute the dung, which after a time is pumped up, and either carried in water-carts to the meadows, or mixed up with earth and the litter of the horses into a compost.

The cows usually come into their winter quarters in November, and are put out to graze in May if the weather is mild. When first the cows are let out into the meadows a piece of coarse cloth is put over their loins and tied round their bodies, to prevent the injurious effects of cold dews and fogs; when the air is warmer this is discontinued.

The milk-room, or rather cellar, is almost invariably vaulted, and sunk somewhat under the level of the ground. The floor, which is laid with porous tiles, is always kept wet by continual washing, and the evaporation tends to keep the cellar cool in summer. The milk is brought from the cow-house in large brass vessels in the shape of the Etruscan water-cans. As the cows are milked the pails are emptied into these cans, which, when full, carry the milk without much shaking. When the milk-cellar is very near the cow-house the can is dispensed with, and the pails are carried at once into the cellar and emptied into deep earthen pans. In some dairies the milk is set in shallow tubs or pans, as in England, but in most of them this is not the case. Each milking is kept separate; and when the milk is three or four days old, and becoming slightly acid, it is poured into a large upright churn, of which the plunger is worked up and down by means of a crank and machinery moved by a horse. In some smaller dairies a dog runs in a wheel, and by his weight causes the motion. In private families the servant churns the butter by means of a lever which works like the handle of a pump, and moves the plunger up and down, as is done with the bucket in the pump. The butter is usually taken out of the churn on a sieve or cloth, which lets the buttermilk run through;

it is worked with a very cool hand, and salt is added as soon as all the buttermilk is pressed out. This is essential to its keeping quality; and no Dutchman would touch butter which had no salt in it, however fresh it might be. The butter made in summer when the cows feed in the pastures is of a very fine golden colour and agreeable taste. Where the pastures are not so rich this colour is sometimes given artificially by means of scraped red carrots put into the milk, or by annatto-root, as is done with cheese in England; but the natural colour of the best butter cannot be imitated, and none but the inexperienced are deceived.

The salt used in curing butter, as well as fish, is of a peculiar quality. It is crystallized in hollow pyramids composed of minute cubes. This is effected by allowing the salt to crystallize very slowly. Sea-water is boiled to a certain degree of saturation; and the boiling is continued very slowly, so that the muriate of soda separates from the other salts. The crystallization generally begins at the surface of the water by the formation of a cube surrounded by a rim of cubes forming a hollow inverted pyramid, which increases along the outer edge till the crystal becomes too heavy to float, when it falls to the bottom. It is nearly pure muriate of soda, and very little deliquescent. This salt is dried in an oven, and then pounded, and ultimately worked into the butter. The casks in which the butter is packed for sale are made of very white clean wood. The inside is well washed with strong brine, and the butter is pressed closely into it. A cask must be filled at once, and, some salt being strewed over the surface, the head is put in, and it is ready for exportation. The pasture, no doubt, gives the richness to the butter; but it is the extreme attention to minute particulars, and especially the extraordinary cleanliness of everything which is connected with the dairy, which gives the Dutch butter its great reputation.

Cheese of various kinds is made in different parts of the Netherlands. That which is the best is a new-milk cheese called *Gouda cheese*, from the name of the town in Holland near which it is made. The little round Dutch cheeses, which are exported in great quantities for ships' provision, are made in the neighbourhood of Edam: some of the cream has been subtracted and made into butter, and the cheese is what would be called half-meal cheese in England. It is very strongly salted, by soaking it in brine. It is said that the curdling is produced by muriatic acid instead of rennet; but this is not generally the case. The common skim-milk cheeses made in Holland have seeds of cummin mixed with the curd, and are made of the size of our Cheshire cheeses. It is but a poor cheese, and seldom exported. When it is grown hard it is cut into very thin slices, and usually put upon bread and butter; thus the pooriness of the cheese is corrected,

and the cummin gives a flavour which habit makes agreeable. Buttermilk forms a considerable part of the food of labourers and mechanics, as well as of children. They make a kind of soup of it by boiling shelled barley in it, and sweetening it with treacle or sugar. If it requires early habit to relish this mess, it is both nutritious and wholesome to those who like it.

Very large oxen are fatted in the rich meadows of North Holland. They have large bones, and in some points would not satisfy a judge of a Smithfield show. But it must be recollected that milk is the chief object of the breed, and that good milch cows are invariably deficient in some points considered essential in a perfect ox reared only for fattening. The meat of the oxen which are killed in Holland is excellent, and when salted makes the best of ship provisions. Sometimes they are fatted with oil-cake, and many with the wash from the distilleries; but in general they are simply fatted on hay and grass, which make by far the best meat.

The sheep in the Netherlands are large long-legged animals, with dropping ears, which have nothing but their size to recommend them. Merinos have been introduced, and some flocks of mixed breeds are to be found which have finer wool than the old indigenous breed. Some Leicester sheep have been imported from England, but they are merely objects of curiosity. The rich pastures in Holland are well suited to this breed.

The horses in the Netherlands may be divided into two distinct breeds, the heavy Flanders horses, which are either light chesnut-coloured, with white tails and manes, or roan. They are bulky, but not active, and not to be compared with the Suffolk punch, which breed came no doubt originally from Flanders, but is much improved by a judicious choice of both the mares and stallions selected for breeding. The Friesland horses are mostly black, and some of them are very strong and active. A breed of very fast trotters is encouraged by trotting matches, and thus considerable activity is infused into the breed. A good Friesland horse will do much work and draw very heavy loads. Oxen are seldom seen to draw a plough, all the farm-work being done by horses. The Dutch waggons are light, with a very narrow track, to accommodate them to the narrow roads on the tops of the dykes. A pole would be a great incumbrance in turning within a very narrow space; hence a curious substitute has been adopted—a very short crooked pole rises in front, and the driver directs it with his foot. A person unaccustomed to its use could never drive a Dutch waggon, which requires great skill and judgment to steer it. A drunken driver is discovered a long way off by the oscillations of his waggon, which frequently runs off the dyke and is overturned into the ditch on either side, the horses having no

power to keep it straight when the crooked pole has not a steady foot to guide the front wheels. The Dutchmen always make their horses trot in the waggon when not heavily loaded, by which much time is saved in haymaking and harvest; and the horses, being accustomed to it, naturally trot like carriage-horses, when the load and the roads permit. Many of the roads in Holland are paved with hard bricks called *klinkers*, set on edge, and run like railways. On the whole there are many points in the husbandry of the Netherlands which are worthy of adoption. The principal object of good farmers seems to be to imitate as much as possible the garden culture in the tillage and clearing the ground from weeds. The spade is much more in use in finishing the work of the ploughs and harrows than with us, and also in trenching the ground. Manure is carefully accumulated and preserved, and seldom allowed to be washed away, or diminished by long and injudicious fermentation, but is mixed with earth to retain all the volatile parts, and carried to the land in a state of compost. All the urine is carefully collected, and its value is fully appreciated.

There are no doubt many farms which do not come up to the description here attempted; but our object is to present to the reader what may be worthy of imitation, or which may lead to some improvement in our own practices—without drawing invidious comparisons of the general state of agriculture, when the defects of one system are contrasted with the improvements introduced into another, and the best cultivated lands in one district are compared with the least improved in another.

XX.—*On the Planting and Management of Forest-Trees.*

By CHARLES FALKNER.

THE subject of the following pages is immediately connected with the promotion and improvement of agriculture, by the beneficial effect of woods and plantations in deepening and enriching the soil upon which they grow, by the improvement their shelter effects in the climate of adjoining lands, and their consequent increased fertility, and by their affording an abundant supply of indispensable material for buildings, implements, and fuel.

To these must be added the indirect benefit they afford, by giving employment to agricultural labourers at a period of the year when many would otherwise be unemployed.

Besides the direct and indirect advantages which the cultivation of woods and plantations yields to agriculture, it presents a sure and rapid means of increasing the value of landed property

of inferior quality, and that by a comparatively trifling outlay, while it affords a source of the most agreeable and rational amusement to the active and enterprising proprietor, which, if pursued only up to the limit of absolute utility and profit, would render many a wild and useless waste, not only a scene of industry and a source of wealth, but also an object of pleasure and admiration.

I propose to treat, in as concise a manner as is consistent with clearness, 1st. The physiology, or the structure and manner of the growth of trees. 2nd. The leading character of each individual kind usually cultivated, and the soil to which it is best adapted. 3rd. The formation and management of nurseries of forest-trees. 4th. The different modes of planting according to the nature and situation of the land. 5th. The management of trees and of woods and of plantations by thinning and pruning.

A tree may be considered as an assemblage or system of curious organs, destined to support its life, enlarge its dimensions, and continue its species. Some knowledge of these organs and the functions they perform is quite indispensable to those who undertake the management of growing timber; for it is owing to ignorance of this subject, that we everywhere witness woods and plantations, as well as hedge-row timber, rendered almost worthless from deplorable neglect, or suffering under the most injurious treatment, which it is impossible to attribute to any other cause. So general, indeed, is this evil, that a few hours' ride, with this object in view, in almost any part of England, fills the mind of the observant traveller with astonishment and regret at the immense loss thus incurred both by individuals and the public.

The organs of a tree present themselves under five distinct arrangements or divisions: the root, the stem, the bark, the leaves, and the blossom. The root divides into numerous branches, and these again into almost innumerable filaments or fibres; these consist of cells, and sap and air vessels or tubes, and at the termination of these tubes, in the extremities of the fibres, they present very numerous and minute pores or mouths, collectively called spongioles. The stem or trunk may be considered as a compact union, above ground, of the same system of cells and air-vessels, which ascend to the extremities of the branches, and diffuse themselves through every portion of the leaves. In the leaves other tubes or vessels originate, unite in the foot-stalk, invest the twig forming the bark of the tree, and thus descend to the extremities of the roots. Thus is there a continuous connexion of the same or a similar system of cells, and sap and air tubes, extending from the extremities of the rootlets or fibres to the leaves, and reciprocally descending again to the roots. When a tree is cut transversely, the bark and the wood exhibit the following appearance:—Beneath the rough external coating which consists of old

bark, will be seen a thin transparent membrane, called the epidermis; under this, a green pulpy vascular matter, which in the root is colourless; and then the true bark or liber, consisting of tubes and cells, somewhat resembling the sap-wood beneath. The wood consists of two parts, the sap-wood and the heart; these are of the same nature, only that the sap-wood, or outer part, is whiter and less firm in texture, and is that part through which the greater portion of the sap is transmitted to the branches and leaves. Straight lines of apparently a more compact substance radiate from the centre to the bark; these are collectively called the silver grain, which differs considerably in the different kinds of trees, and presents to the curious in timber, a means, by which one kind much resembling another, may be readily distinguished in the dry state. If a small branch or twig of the same tree be divided in the same manner, the like appearance will be presented, except that there will be no heart-wood, and the centre will be occupied by a soft substance called the pith, which, though originally visible in the stem of the sapling tree, disappears from that part as the tree advances in age.

If a very thin transparent slice be taken off the twig and placed under a powerful microscope, the pores, or interstices of the cells and vessels, both in the wood and bark above described, will be distinctly visible. Before speaking of leaves, it may be proper to premise that the atmosphere contains about 1·1000 part of its weight of carbonic acid gas, consisting of carbon united with oxygen in the proportion of 6 parts of the former to 16 parts of the latter. This gas arises from the combustion and putrefaction of vegetable and animal substances, and the breathing of animals; and if it were allowed to accumulate, the air would be rendered unwholesome and unfit to support life. It is one of the most important offices of the leaves to separate the carbon from the oxygen, by which the latter is set at liberty, and passes again into the air, while the carbon, uniting with the elements of water in the leaves, forms the true sap which produces the wood, or at least about 95 parts in 100 of that substance. The other 5 parts, which constitute the ashes when wood is burnt, consist of earthy and alkaline salts, which are taken up from the earth by the roots in a state of solution. Thus the leaves purify the air, while they abstract from it a large portion of the substance of the tree. It appears, therefore, that the leaf is the most essential of the organs of vegetation, if indeed any preference in point of utility can be claimed, where all are dependent upon each other. This curious organ, as was noticed before, is composed of the tubes with their accompanying cells, which ascend from the trunk and branch out in every direction, constituting what are commonly, but improperly, called the nerves of the leaf. The spaces between these

are filled up with a vascular or pulpy green substance, similar to that beneath the transparent membrane of the bark, and the whole is covered by the same kind of skin, furnished with almost innumerable pores, chiefly on the under side, which serve the purpose of transpiration, or of communication between the air and the internal part of the leaf. I have observed that the coating of the leaf is colourless and transparent, and therefore it is the hue of the pulpy or vascular matter peculiar to each plant, which imparts that agreeable variety of green so remarkable in the vegetable kingdom. The calyx and corolla of the blossom have a similar construction to that of the leaf; but a particular description of its several parts is not essential to the present object.*

As the temperature of the spring increases, the spongioles of the fibrous roots expand, and absorb the surrounding water, which contains in solution carbonic acid gas and common air, with minute portions of alkaline and earthy salts, such as the soil affords. This incipient sap, passing through the larger branches of the roots and the alburnum of the stem to the extremities of the tree, carries with it the elaborated matter, or true sap, which had been deposited in the cells or interstices of those parts in the previous autumn, and which, now mixed with the new sap, serves to develop the leaves and blossoms, the buds of which had been formed in the previous summer. I must here observe, that the sap-vessels communicate also sideways with each other, so that when a branch is cut off, the sap which otherwise would have gone into it receives a new direction. Just before this development of the leaves takes place, if an incision be made into the alburnum, or sap-wood, the sap exudes copiously; but as soon as the leaves are opened this bleeding ceases, in consequence of the sap being determined towards them. In the leaves, when fully developed, the sap which continues to ascend comes in contact with the external air by means of the pores already described, through which it receives carbonic acid gas; by the action of light upon the leaves, the sap undergoes a curious elaboration, gives off its redundant moisture and oxygen gas, and becomes what is called cambium, or true sap, which descends through the vessels of the bark to be deposited as a new layer of wood, and to form new bark and new roots. In the autumn a change takes place in the destination of the descending sap, and it then no longer forms wood, but is deposited in the cells of the alburnum and of the roots, which serve as reservoirs to perform its part in the ensuing spring as before described. In the winter, therefore, the cells of the alburnum and the roots are swollen with this elaborated sap, con-

* For a more particular description of the several organs, I refer the curious reader to the 'Elements of the Organs of Plants,' by Decandolle and Sprengel.

sisting principally of starch, which is so abundant in the Norway pine as to be used by the natives of that country in scarce seasons for making bread. Thus a new layer of wood is formed every year, covering that which was produced the year before, while the inner layer of the alburnum is converted into heart-wood. A new bark is also produced, while the old is thrust outwards, and is either exfoliated, as in the birch and plane-tree, or forms that deeply furrowed mass of dead matter which encrusts the elm, oak, and other trees. The office of the pith is not known, but as it is always found in the annual shoots and twigs, it is probably essential to the buds and leaves.

I trust that the above brief description of the organs of trees, and the functions they discharge, will not be deemed irrelevant in a work of practical instruction, for I am confident that it is only by the diffusion of this kind of knowledge, the evils of mismanagement, to which I have before alluded, can be effectually arrested. We have enough of practice without knowledge in this important department of rural economy, as the present condition of most of our woods and plantations sufficiently testifies, and it is therefore high time to adopt a practice founded upon knowledge. It is well known what fatal errors were committed in surgery before anatomy was understood; and most of the sylvan doctors have yet to learn the physiology of trees.

In speaking of the different kinds of trees, I shall premise a few observations upon the natural causes which determine their localities. The distribution of timber-trees, like that of all the other vegetable tribes, depends upon two principal causes, climate and soil. Climate is equally the effect of latitude and elevation; accordingly, we find trees of similar kinds, if not identically the same, growing on the elevated sides of the Andes and other lofty mountains within the tropics, and by degrees descending, as the latitude increases, to lower situations, until they are found occupying the low plains on the banks of the Lena and Coppermine rivers near the Arctic Circle.

While climate effects the general distribution of trees by means of temperature, the localities of different species of trees in the same climate are determined in a great measure by the nature of the soil; most deciduous and soft-leaved trees require a much larger quantity of potash than those of the pine tribe; and such trees are therefore found in low situations, on secondary and tertiary strata, and diluvial plains, the clays of which abound with that substance, while the pine tribe, which require but little potash, principally occupy the light sandy levels and the sharp thin soils of mountainous regions. It is not therefore the mere firmness or openness of the soil which determines the production of particular trees, but the presence of those substances which

such trees require for their nourishment, amongst which potash is the most influential. This is strikingly evinced by the remarkable circumstance, that when forests of pines in North America are destroyed by fire, oaks and other deciduous plants spontaneously succeed them, owing to the presence of potash, which had been accumulating for ages by the growth of the pines, and is thus abundantly furnished by their ashes to the plants which require it. Whatever alkaline or earthy substances are constantly found in the ashes of particular trees, these are necessary to their existence, and the presence of them in the soil must have a principal share in effecting the distribution of such trees; they grow very slowly where such substances are insufficient, and refuse to grow at all where they are entirely absent.* To such minute, and generally unnoticed, causes, are to be attributed the predominance of particular trees in certain localities, and that beautiful and ever varying change of tint and foliage which diversifies the aspect of forests, and constitutes the principal attraction in the enchanting scenery of nature.

In this country, which is singularly favoured in regard to soils, we have every variety which geology presents, from the most recent to the oldest formations, and have therefore a greater range of natural adaptation than can, perhaps, be found in any other part of the world of equal dimensions; and to this cause, united with the mildness and humidity of the climate, is owing the lively verdure and attractive variety for which British scenery is so remarkable. With these advantages, there are few forest-trees of the temperate zones which might not be naturalized in this country, and many of the most valuable, which were unknown to our ancestors, have long since been extensively cultivated, while there is little doubt that some valuable additions may yet be made from the western continent.

I now proceed to enumerate the principal and most valuable trees which constitute the British Sylva, with a brief character of each, and with some notice of its geological or natural distribution, as a guide to the selection of those soils and sites to which it is best adapted. In doing this I shall omit many species that are not commonly planted, the insertion of which would be incompatible with the limited nature, and useless to the principal object, of this paper.

The common oak (*Quercus robur pedunculata*) is, from its size, and the strength and durability of its timber, the most valuable tree of the British forests. It flowers in April and May, and bears its fruit upon long foot-stalks, a peculiarity which dis-

* See Liebig's 'Chemistry of Agriculture and Physiology,' a book which should be in the possession of every landed proprietor and every intelligent agriculturist.

tinguishes it from the Durmast oak, an inferior species, and is important to be regarded in gathering the acorns for planting. In a genial soil this tree has been known to attain the height of more than 100 feet, and to produce upwards of 800 feet of timber. It preserves its flourishing head and the soundness of its timber to a greater age than most other trees, its great longevity justly entitling it to the epithet "monumental." The value of its bark is well known; a tree with a large full head generally produces 5 cwt. to each ton of timber. It is needless to say anything of the superior quality of its timber or the multifarious uses to which it is applied.

The oak grows spontaneously in almost all soils abounding in clay, and therefore is plentifully found in the London, Plastic, Wealden (as may be seen in Kent and Sussex), and Oxford clays; in all the valleys which descend through the oolitic system, which abounds in subordinate beds of clay and marl; in the lias beds, and in the aluminous portion of the new red-sandstone, the shales of the coal-measures, the clays of the old red-sandstone, and in the detritus of the valleys of the grauwacke slate; but it attains its greatest dimensions upon deep strong diluvial soils, which consist chiefly of clay and gravel. In very cold and wet land, such as the four first strata often present, it is of stunted growth, and does not arrive at any great size. At considerable elevations and in exposed situations it does not thrive well, but becomes tortuous and knarly.

The Turkey oak (*Quercus cerris*) is a beautiful tree, and not undeserving the attention of the profitable planter, as it grows rapidly with a clean stem; it flowers in May; its fruit is small, and the cup rough and prickly. The land* most favourable to the common oak is also suitable to this.

The seed of both the above may either be planted in the fall, or preserved in sand till the ensuing spring, and planted in February and March; the latter is the preferable method.

The Spanish chesnut (*Fagus castanea*). This noble tree is common to all the south of Europe, and was introduced so early in England as to have given rise to the supposition that it is indigenous: it flowers in June. Too much cannot be said in praise of its beauty and magnificence, and its timber is next in value to the oak; it grows to a very large size, and lives to a great age, one of the oldest trees in England being of this kind; it stands in Lord Ducie's park, in Gloucestershire, where, there is reason to believe, it was growing at the time of the Conquest. This tree grows freely in healthy gravels and other diluvial soils, as

* The Turkey oak is said also to thrive and grow rapidly on land which is too light for the common oak. It forms many of the forests of Italy. The fine oaks round the Lake of Bolsena are of this variety.—PH. PUSEY. 2

well as in good sands and loams ; but the soils and situations in which it prospers best are those on the lower slopes, and in the valleys of the older rocks of the transition series, particularly those of the grauwacke, where it rises spontaneously, and often arrives at an immense size. Where the valley of the Tamar cuts through this rock I have seen one whose three principal branches are each equal to a very large tree. Its seed should be planted in February or March.

The common English elm (*Ulmus campestris*) may be said to be a weed of the soil, as it propagates itself in the hedgerows of most of the fertile soils of the south of England, but is observed not to prevail much in the more northern counties. Though it is generally found to attain its largest dimensions in rich bottom meadows and deep diluvial soils, it nevertheless grows to a very great size in some of the regular strata, such as the richer portions of the greensand, the ironsand, the inferior oolite, and in the deep marly land of the new red-sandstone. It is often found thriving well in conjunction with oak ; but on very stiff clays its progress is slow and its appearance stunted. It is very grateful for manure, and with such aid grows to a great size even on firm clay, as may be seen on some of the wide and rude farm-yards in the west of England. It produces its flowers in April and May. As this tree abounds so much in hedgerows, it is seldom planted but in parks and pleasure-grounds for the purpose of ornament and shade, where, from its rich and dark foliage and beautiful outline, it forms the principal grace. The toughness of its timber and its durability under water recommend it to the ship-builder for the keels of ships ; and it is applied to many valuable rural purposes. The miserable practice of shrouding and pollarding this tree, in a large portion of the south and west of England, is exceedingly unsightly and disgraceful. If the under branches were gradually and carefully removed during the early stage of their growth, they would prove less injurious to the adjoining land, and more creditable to the proprietor. Indeed pollards of every kind are a disgrace to an estate upon which they are suffered to stand.

The Cornish elm is seldom seen but in that county ; it somewhat resembles the common elm in its general appearance, but is much smaller, and the timber is whiter. It appears to be confined to the more sheltered parts of the county, and grows in the hollows of the clay slate.

The Wych elm (*Ulmus montana*) grows with long-spreading branches ; its leaves are much larger than those of the common elm, but it is very inferior to that tree both in depth of shade and beauty of outline : its timber, however, is almost equally tough, and it will attain a considerable size where the other would

scarcely make any progress. It is suited to almost all healthy soils, and thrives equally well on clays, gravels, and sands, but appears best adapted to the detritus of the transition rocks and the sides and bottoms of upland valleys. It flowers in April and May, and is propagated both from seed and layers.

The ash (*Fraxinus excelsior*) grows spontaneously on most light and cool soils, and abounds in all the valleys of the secondary and transition formations; and it is in the loose soil of the latter that it attains its largest dimensions, sometimes exceeding a hundred feet in height. Its fine branching head and drooping spray give it a very graceful appearance, even when divested of its leaves. Its wood is proverbially tough, and is applied to a greater variety of useful purposes than perhaps any other. It is bi-sexual, and produces its flowers in April and May. The seeds are generally preserved, and sown in the following spring.

The beech (*Fagus sylvatica*) is best adapted to light dry calcareous soils, but succeeds well in most others. It grows spontaneously on the thin oolitic soils of Gloucestershire and Buckinghamshire, where it arrives at a great size, and forms extensive and magnificent woods. This tree perhaps produces more timber upon a given space of ground than any other. I have seen several large trees, whose timber measured 800 feet, growing upon a space which would be occupied by one good-sized oak. The compactness and beautiful grain of the timber has recommended it to general use for a great variety of cabinet-work; and its durability under water renders it valuable for keels of ships and for piles. It is, however, liable to rapid decay when exposed to the weather, and requires to be sawn up soon after it is cut, to prevent its perishing in the mass. Its lively verdure, thick foliage, and rich autumnal tints render it a favourite as an ornamental tree. As it resists the heaviest gales in exposed situations without distortion, no other tree, except perhaps the sycamore, is so well adapted for shelter against the long winds which prevail on the western coasts. It flowers in April and May, and its seed should be preserved and sown in March.

The hornbeam (*Carpinus betulus*) somewhat resembles the beech in its general appearance; it is, however, of inferior size, and but little esteemed as a timber-tree, though it is valuable as a screen, owing to its retention of its dead leaves during the winter. It appears best adapted to stiff clayey soils of the inferior kind, or, at all events, succeeds well in them. As such soils are very prevalent, and this tree yields a firm and valuable wood, it is perhaps deserving of more attention than it has hitherto met with. It usually flowers in May.

The common sycamore (*Acer pseudo-Platanus*). Besides the full and lofty head which recommends this tree for shade and

ornament, it is but little affected by the most violent winds, and therefore serves as an excellent screen for plantations of other trees. It grows to a great size on most cool soils, but seems better suited than most deciduous trees to the elevated plains of the mountain limestone and other transition rocks, where it sometimes grows to the height of 70 or 80 feet in very exposed situations. Its wood is valuable to the turner for making bowls and other domestic implements. On the Continent it is much used for cabinet-work and the fabrication of violins and other musical instruments. It flowers in April and May, and is propagated by seed, generally sown in the spring.

The plane-tree (*Platanus Orientalis*) is a native of the south of Europe, and of Western and Central Asia, where it often attains an enormous size, of which there are some remarkable specimens on the shores of the Bosphorus. The timber of this tree is not considered valuable, and it is chiefly prized for its great beauty as an ornamental tree. It succeeds well both in gravels and clays, but grows with the greatest luxuriance in deep alluvial soil and calcareous detritus. In the rich soil of a valley which descends through the chalk in Dorsetshire, on the estate of Lord Portman, I have seen two trees of this kind, which were said to be 120 feet high, and are perhaps the finest in England.

The acacia (*Robinia* or *pseudo-Acacia*) is a native of North America. This tree grows with great rapidity in its early stage, putting forth fresh volumes of leaves through the summer; but as it advances in age it abates much of this vigour, and at length makes less progress than the oak. It appears to be best adapted to sands, but will grow in almost every variety of soil that is not wet. In America it is propagated with great facility by merely severing the roots with a sharp spade; numerous suckers spring from the separated roots, and a thick wood is soon produced. It is much given to send out strong branches near the ground, and therefore requires the restraint of neighbouring trees, and to be carefully attended with the pruning-knife. Its wood is exceedingly hard, and almost imperishable. Very conflicting opinions have been entertained of its value as a forest-tree, but it seems well deserving the attention of the planter. It produces a beautiful white flower in May and June. The seeds are sown in March and April. This tree should always be well sheltered, on account of the extreme brittleness of its young boughs.

The black Italian poplar (*Populus nigra*) is a very fast-growing tree, thrives well on all cool and moist soils, and produces more wood in a given time than any other tree. Its value in this way is so well appreciated in Italy, that it is a common practice for a man to plant a number of them on the birth of each daughter, as a provision for her dower; an admirable practice, and well de-

serving of imitation. The timber of this tree produces excellent flooring-board, which is but little combustible; it is also valuable for packing-cases and a variety of other purposes where tough board is required.

Lombardy poplar (*Populus dilatata*). Very little attention has been paid to this tree with a view to its timber, though it can be little or nothing inferior to the foregoing; and it is worth inquiry, whether its peculiar form of growth would not be favourable to its producing more wood upon a given space of ground than others of its species. It is also rather questionable whether this beautiful tree has not been too much neglected as an ornamental tree, in our desire to avoid in decorative planting that precision and uniformity which was imported from Italy, and with which the poplar was so much identified.

The abele (*Populus alba*). This tree may be distinguished at once from the aspen and the hoary poplar by the very horizontal growth of its boughs, as well as by its downy leaves and the straightness of its stem. It grows very rapidly in deep beds of peat, from which the water has been led off by open drains; and its timber is equally valuable with that of black poplar, and for the same purposes.

The willow (*Salix*). Of this tree there are numerous varieties, of which the Huntingdon willow appears to be the most valuable as a timber-tree. Its localities are well known to be low, wet situations, and the banks of rivers and brooks. In certain situations, particularly near London, its wood sells for a high price, for peculiar purposes, which makes it a most profitable tree.

The alder (*Alnus glutinosa*) is best suited to peat-bogs and irreclaimable swamps: in such situations, where no other tree will thrive, it grows with great rapidity; and though the wood is of a perishable nature, yet if it be peeled as soon as cut, it will last many years in the dry. The wood is used for many manufacturing purposes, and the lop is used for draining. It may here be observed that the discoveries of modern chemistry have equalised the durability of all woods, which can be secured at a comparatively trifling expense.*

The lime (*Tilea*). Of this tree there are two varieties, the common and the red-twigg'd; the latter is the most esteemed, and is a great favourite as an ornamental tree, from the fragrance of its flowers, its graceful form, and lofty growth. Its timber is chiefly useful for the purposes of the carver, and its bark furnishes the material of the bast-mats used in gardens. It is not adapted to exposed situations, and requires a healthy and good soil, though

* By steeping the wood in a solution of corrosive sublimate.—Kyan's patent.

the common lime grows spontaneously on the lias shale in the west of England, and perhaps would succeed in most moist or cool soils. It flowers in June and July; and is generally propagated by layers.

The birch (*Betula alba*). There are two native varieties; one growing with straight firm boughs, and the other called the weeping-birch, from its beautifully pensile spray. The young plants resemble each other; but the weeping-birch may be distinguished from the other by the numerous tubercles on the stem. The birch is a very hardy tree, and is the last that yields to the rigour of climate on the frozen plains of the north, and the elevated sides of mountains. It is found on most poor soils, and frequently occurs in coal shales in South Britain; and such is its general adaptation, that it may be considered the forlorn-hope of the planter.

The horse-chesnut (*Esculus hippocastanum*) must be considered merely as an ornamental tree, but one of such remarkable beauty, both of foliage and blossom, as to demand a place in every treatise on forest-trees, however brief. The wood is of no value except for fuel. It grows in almost any kind of soil; but arrives at its largest size on deep and healthy sands and loams. It flowers in May; and the seeds may be planted in October or November.

Resinous or Cone-bearing Trees.

Of these trees it may be observed generally, that they occupy the colder portion of the temperate zone, whether the climate be owing to high latitude, or elevation, or to those causes which effect a variation of temperature in different countries under the same parallel. In the north-west of Europe, the region where the pine tribe prevails, is more limited towards the South than in North America, where the lines of equal temperature descend many degrees as they traverse that continent; and the same takes place in the opposite direction across Asiatic Russia, where pines prevail in much lower latitude than on the shores of the Baltic and of Western Europe. Besides temperature, and those causes before noticed, which effect the distribution of trees, there is another which must exercise great influence. The hard, firm leaves of the pine tribe exhale much less than the soft leaves of deciduous trees; and therefore such trees are enabled to grow in situations where less rain falls, and in soils less retentive of moisture, such as the dry, sandy levels in the interior of continents, and the thin soil on the elevated slopes of mountains. There can be no doubt that each of the causes mentioned has its effect in varying the prevalence of one or the other kind of trees, in proportion to the degree in which it exists. The sides of

Mount Etna exhibit a remarkable instance of the effect of elevation upon the distribution of trees. Brydone observes, that at the base of that mountain, and for a great way up its sides, forests of chesnut and other deciduous trees prevail; these are succeeded by a broad belt of pines, which yield in their turn to the severity of the climate as the elevation increases. These additional observations upon the natural causes of the distribution of trees were suggested by the transition from one great family to another, between which nature has drawn so strong a line of distinction. Inquiries of this kind cannot fail to interest the enlightened cultivator; for by diligently tracing effects to their causes in the striking phenomena of the distribution of plants, we shall not only be able to arrive at just conclusions with regard to the effect of the more obvious causes which exercise so powerful an influence, but also as to the nature and extent of those scarcely less influential causes which determine that particular distribution we witness in the same climate, and in soils which present little or no apparent difference; a path of investigation which is calculated to extend our control over the productive powers of nature, and upon which the writings of Liebig and Sprengel have thrown so much valuable and interesting light.

The larch (*Larix pinus*) appears to be a native of most of the mountainous parts of the south of Europe, and is said to derive its name from Larissa in Thessaly. It abounds on the northern slopes of the whole range of the Alps, chiefly on mica schist, but often on limestone; and its range is so extensive, that it is found as a dwarfish shrub on the frozen plains that approach the polar circle on both continents. The extensive plantations of the Duke of Athol are on mica schist, in the soil of which the larch appears to prosper better than on any other. Some portions, however, of those plantations are on clay slate to the south, and gneiss to the north. Though this tree may be best adapted to mountainous situations, and the more ancient strata, it nevertheless thrives well on almost every variety of soil except chalk and very wet clays. There are a few trees at Dunkeld which in fifty years rose to the height of 120 feet: these were planted in the low ground; but the larch thrives rapidly in these plantations at an elevation of 1600 feet, and even 1800 feet, above the level of the sea; while the Scotch fir in the same situation makes scarcely any progress. This superior growth of the larch induced the late duke to plant 6500 acres entirely with that tree.

In the papers of the Highland Society it is reported, from the duke's memoranda, that in his plantations, at an elevation of from 900 feet to 1800 feet above the sea, the average growth of the larch is as follows:—For the first fifty years, 16 inches annually in height, and 10 inches per annum for the next twenty-two years,

which gives an average of 85 feet in seventy-two years. In girth they increase at the rate of 1 inch per annum for the first fifty years, and $1\frac{1}{4}$ in. for the remaining twenty-two years. In another part of these memoranda it is stated that at fifty years old the trees contain 26 cubic feet of timber; at sixty years, 40 feet; and at seventy years, 60 feet.

In 1806 the duke cut down 20 larch at the age of sixty-four years, all measuring upwards of 100 feet in height, and containing from 80 feet to 90 feet each of timber, which was sold by auction at 2s. 8d. per foot. In another instance 11 trees produced 1006 feet of timber, which sold at 3s. per foot to the shipbuilders.

Two hundred and twenty-three trees, of fifty-seven years' growth, were sold to government, and measured at Woolwich Dock-yard 40 cubic feet each, upon an average; and 600 trees, cut down in 1811, at sixty-four years' growth, produced at Woolwich 606 loads of timber.

Fifty Scotch firs, and fifty larch, growing near each other, and of the same age, were cut at the same time; the Scotch firs averaged 8 feet of timber, and the larch 30 feet!

In these highly interesting memoranda the duke says that he is quite of opinion that the final crop of a Scotch acre planted with larch will be worth 1000*l.*, even valuing the timber at half the price which he actually obtained. In such an estimate, however, it will be reasonably supposed that there is some source of error, and this is the more probable from the distance (12 feet) assigned for the trees of the final crop, which appears much too near to produce trees of the scantling above mentioned, and upon which it is presumed the calculation is founded. However this be, these plantations reflect the highest honour on the memory of the late duke, and hold out great encouragement to others to follow his noble example. The timber of this tree is very tough and durable, and is applicable to a great variety of purposes, but is more particularly serviceable in both domestic and naval architecture. Enormous beams of this timber were used in the buildings of Venice, in her palmy days, which are said to be quite sound at the present day, though the buildings must be at least 400 years old. So powerfully does this wood resist the causes of decay, that even the twigs retain their toughness for years. This beautiful and valuable tree flowers in March and April. The best seed is procured from the Alps, which should be sown in April.

The Scotch fir (*Pinus sylvestris montana*) is a native of Sweden, Norway, Prussia, the Alps, Pyrenees, Caucasus, and other mountains of the south, as well as of Scotland. In the latter country there are still the remnants of native forests existing on the banks and in the valleys of the Spey and Dee, and a few other situations. The principal appear to be those of Abernethy,

Strathspey, Mar, Morriston, Strathglass, and Glentanner: these are all upon gneiss, except Glentanner and part of the forest of Mar, which appear to be on granite. They seem to be fast diminishing; and perhaps some of those mentioned above have already disappeared. The timber is said to be quite equal to any brought from the Baltic: its colour is red, and the wood so resinous as to be substituted for candles. The true Scotch fir, or montana, grows with tortuous branches, somewhat resembling the oak; arrives at a great age, and is often from two to three feet in diameter. A plank was cut from one in Glenmore Forest, measuring 6 feet long and 5 feet 5 inches broad, which is now in Gordon Castle. I have seen a tree of this kind in the south of England, which contained 5 tons of sound timber: it grew in calcareous sand. The other and inferior varieties of this tree may be distinguished by their conical heads. One of these is found in the same forests with the montana; the others are said to be brought from America; and their inferior quality has brought the true sort into disrepute, by being substituted for it. Though the native sites of the Scotch fir are in mountainous valleys and sandy soils, yet it succeeds well upon almost any soil, except such as are very wet. Though the fir tribe seem no longer native to South Britain, there is unquestionable evidence that they were indigenous at some very remote period, as I have seen trees of this kind of very large size, in a complete state of decay, deeply embedded in the bog earth or peat of the greensand. The Scotch fir flowers in May and June. The seed is sown in April.

The spruce or Norway fir (*Pinus abies*) is one of the most valuable of the resinous tribe, for the straightness of its growth, and the durability of its timber even when young, which renders it very serviceable for masts, spars, and scaffold poles. It yields the white deals brought from Norway and the coasts of the Baltic, but is considered not equal to the red deal, the produce of the *Pinus sylvestris*. As a plantation-tree it is admirably adapted for a nurse, by its numerous boughs and thick foliage. When standing alone in all its natural proportions, it often presents an object of great beauty. It is not suited to very exposed situations as a single tree, or in small groups, but in large masses grows with great luxuriance on the elevated plains of transition rocks, particularly the mountain-limestone. It does not succeed on very dry soils, but will thrive well in damp and even swampy situations.

The silver fir (*Pinus Picea*) is scarcely deserving of notice as a forest-tree, as its timber is of but little value. Though it grows more slowly than any other of its tribe in its earlier stage, it makes more rapid advances afterwards, and ultimately towers above all

others. It succeeds best in valleys and in sandy soils, and will often grow to a great height even on those which are very poor.

Nursery Management.

In planting upon a small scale, it will perhaps be found most economical to purchase plants from a nurseryman at the time they are wanted; and even where larger designs are undertaken, it will be quite as much so to purchase seedlings of the pine tribe, and plant them in the nursery till they are fit for their ultimate destination. To those who are, however, desirous of rearing their own plants, the following directions will suffice.

The situation of a nursery should be chosen in a sheltered spot, either within the limits or as near as possible to the land it is intended to supply with trees, and, if possible, near a spring or rill of water. The soil should be a loam or sand, and should in every respect receive the preparation of a well-cultivated garden; by draining, if wet; trenching, manuring, and also by liming, if the land abound with rough vegetable matter, or is not calcareous. It should then be cultivated for garden produce, which will bring it into fine condition for the reception of forest plants. In the interim, that no time may be lost, temporary seed-beds might be formed in a common garden, to supply the first transplanting. However this be, the place selected for the seed-beds should be the most favoured part of the nursery-ground, open to the south, and well defended from bleak winds. The beds for the pine tribe should not exceed 3 feet wide, in order to afford a facility of weeding the plants with the hand, without stepping upon them. These beds should be in high condition. The soil being prepared with a fine rake, the seed should be sown broadcast, so as to afford about four seeds to each square inch of surface. The bed should then be gently pressed with the back of a spade or other smooth instrument, and the seeds covered by riddling some fine damp mould over them, which had been reserved for that purpose. This covering should not be less than a quarter of an inch thick. Each bed should be carefully protected from birds, by nets placed upon thin rods, bent over like a tilt; without this precaution they will be devoured as fast as they appear. The beds should be carefully watered by means of a watering-pot with a fine rose, and occasionally protected from the too great heat of the sun by means of mats or boughs. The utmost diligence should be used to keep the plants free from weeds, and also to protect them from hares and rabbits, which indeed must be effectually excluded from the whole of the nursery. The proper time of sowing is from the middle to the end of April. In two years larch will be fit to be planted out on such lands where they cannot be overtopped or otherwise injured by tall weeds, such as furze, fern, &c. But

those, as well as other coniferous trees, are generally transplanted in the spring of the second year.

The ground for transplanting being prepared, the plants should be removed from the seed-bed by means of raising them with a hand garden-fork, so as not to break or lacerate the fibres, and then placed in a shallow pan containing some puddle made of the same mould, so that the roots may be kept quite moist, and thus conveyed to the transplanting bed. A trench about 3 inches deep must then be made with a line and hoe or spade, and the plants carefully placed in it, the roots being spread with a dexterous touch of the finger at the distance of about 2 inches from each other, then cover them with the hand, taking care to fix them in an upright position. When this is done, proceed to make another trench about 15 inches from the former, and so of the rest. The beds should be narrow, and the lines or trenches made across them, to allow of a facility of hoeing the plants without stepping upon the bed. In order, however, to save room in the nursery, the plants may be ranged lengthwise, if the weeders be cautioned to keep their feet upon the interval which has not been hoed. As the plants when removed from the seed-beds are of very unequal sizes, they should be sorted previous to their being placed in the rows, by which means each will have a fair start. Scotch, spruce, and silver fir should have a little more room in the lines than larch, and will generally require to stand a year longer before they are finally planted out. Larch will often be tall enough after standing one year in the lines, but the others always require two years, and sometimes more.

The seeds of oak, Spanish chesnut, ash, plane, sycamore, and beech, may either be planted as soon as they are collected in the autumn, or kept in dry places in boxes, casks, or bins mixed with sand until the spring; the latter plan is perhaps the best, as they are by that means less exposed to the depredation of field-mice and the contention of weeds. Oaks and Spanish chesnuts should be planted singly in rows about 18 inches apart, with intervals of 4 or 5 inches in the row, and covered about 2 inches deep. The smaller seeds, such as ash, beech, &c., may be sown thick along the drills made with a hoe, and covered about 2 inches deep. Great care must be taken to destroy the field-mice, either by traps or by poison; a figure-of-four trap, with a brick or tile, is generally used for this purpose. Oaks and Spanish chesnuts, managed as above directed, will not require transplanting, but at the end of the second year, if a sharp spade be introduced, so as to sever the roots about 4 or 5 inches beneath the surface, a great quantity of fibres will be formed on the upper part, which will insure the success of the trees when planted out.

As the smaller seeds of ash, beech, &c. will come up thick,

they should be transplanted into rows the following spring, as directed for other plants. The operation of severing the roots by a spade applies only to the deciduous plants mentioned in connexion with it, and perhaps should be confined to the oaks, and when practised should be executed with great care. Elm, plane, and most kinds of poplar may be propagated by cuttings; they should be placed in moist ground, and in rows at least 2 feet apart, with intervals between each plant of 6 inches, and they require no more care than that of keeping them free from weeds by hoeing. The abele, birch, alder, hornbeam, wych elm, and maple, are commonly propagated by layers. Bend down the branches of the plant, make an incision in the bottom of the bight or bend, fasten it down with a hooked peg a little below the general surface of the ground, and then cover it with mould, keeping the top above ground. By making the cut as directed, the branch is not only more easily fastened down, but roots will be more readily formed, and these will be found to proceed from the bark of the upper portion; the vessels of the bark being the organs through which the sap descends to form both the alburnum and also the roots. The layers thus produced will be fit to plant in lines the following autumn or spring. Many plants of this kind may also be planted by suckers, which are produced by laying the roots bare, then making notches in them and returning the mould. I have noticed the rapid manner in which the robinia is propagated in America by merely severing the roots with a sharp spade.

Though it is not strictly within the limits of this paper to speak of apple-trees, I will, however, mention, that to raise stocks, the pulp of apples or of crabs (the latter is preferable), from which the juice has been pressed, may be placed in trenches and covered about an inch deep with mould; the plants will rise in the spring, and must be kept clean by hoeing and hand-weeding. In the following year they should be planted in lines about 18 inches apart, with intervals of 6 inches, and after standing two years should be again transplanted at the distance of 3 or 4 feet from each other, to stand till they are grafted and finally removed. In raising apple-trees, it is an evil practice to cut off the side shoots early, by which the plant is not only checked in its growth, but becomes cylindrical instead of conical, and, in consequence, twists and grows crooked, as is often seen in nurseries of these trees; so little is the office of leaves and twigs understood. At first, such side shoots as are growing very rampant should be shortened only, and others should be removed very gradually, and not finally until the head is cut off for grafting. By adopting this method, the stem will be strong, tapering, and upright, and the plant will be in great vigour to force the graft.

I will observe generally, that the distance at which plants should be set out in nursery lines should be proportioned to the ordinary rapidity of the growth of each particular kind, and the size required before they are planted out, and in this the planter must exercise his own judgment. If a nursery be required to be long in use for the progressive planting of large designs, it should include a sufficient space to admit of having the strength of the land renewed by an occasional interchange of manured esculent crops; but if it is well prepared at the commencement, it will carry three or four successive crops without change. It is almost indispensable to have a small rough garden-house in the nursery, to serve as a tool-house, and for the preservation of seeds, &c. The business of transplanting should be actively prosecuted as soon as the leaf has fallen, or very early in the spring; the autumn, however, is always to be preferred.

The several nurseries I have myself formed and conducted were chiefly placed in such situations as I have recommended, and where the ground had not been previously cultivated. After such preparation, and subsequent cultivation of edible plants for one or more years, the soil became thoroughly broken down and pulverized, and fit for the reception of the tender roots of the young forest plants and of seeds. With such management as I have described, very few plants died when removed to the lines, and the nurseries were entirely successful.

I am aware that there is nothing new in all this to the initiated; it is such a course as common sense and observation would suggest, and I believe is generally practised: nor should I have committed this apparent repetition, but for the argument it affords with regard to the preparation for and future management of deciduous planted trees in certain peculiar soils, whose lives have commenced and whose infancy has been fostered under such favourable circumstances.

Planting.

The proper age for planting out forest-trees must chiefly depend upon the kind to be planted, and the nature of the soil and situation. In elevated and exposed sites, such as hilly and mountainous districts present, where there are no weeds that are likely to injure the young plants by overtopping and whipping them, and where larch and fir are the only suitable kinds, they are generally most successful when planted out very young; the larch as two-years' seedlings, and the Scotch and spruce one year transplanted.

In such situations, when plants of these ages are used, they are best planted by means of the diamond-dibble—an instrument with a heart-shaped or lancet-bit 10 inches long and 5 inches

wide at the insertion of the iron stem, which is $7\frac{1}{2}$ inches long, terminated by a wood cross-handle. The marker having preceded and marked the ground by a cross incision, a man and boy or woman follow; the man strikes the dibble into the ground, so as by depressing the handle the earth opens at the cross-cut made by the marker, the plant is immediately inserted, and the roots carefully straightened and spread by the attendant, and the man fixes it with his heel. One man carrying the plants in a bag before him sometimes performs the whole, but it must be evident that the plan prescribed above will ensure the work being better executed, and with much greater regularity. One well-instructed boy or woman would mark for two or three planters. By means of the dibble the late Duke of Athol (a name that should never be mentioned without respect) planted very extensive ranges of the Grampians with larch, and, he says in his memoranda, with scarcely any failure of the plants, which, together with their subsequent prosperous growth, has proved it to be at once a most economical and effectual method in such districts.

In lower situations, and on the sands and soft soils of the secondary and more recent strata of the south, where the plants would have to contend with broom, fern, and furze, the plants are generally left in the nursery until they are from 12 to 18 inches high. Larch are, for the most part, sufficiently tall after standing one year in the lines, while Scotch and spruce require at least two years from the time of being transplanted. In such situations and with plants of this size, the best method of planting is by previously making holes for their reception in the following manner:—The spots having been marked for each plant, the digger pares off the turf about one inch and a half thick over a space of about 15 inches diameter, turns the turf down upon its face, and divides it in two equal parts, takes out some of the earth, and loosens up that in the hole to the depth of 6 or 8 inches. The planter follows, and with a small adze-like tool, with a short wooden handle, prepares the ground for the reception of the plant, deposits it carefully with its roots spread, draws the earth which had been thrown out over them, and then pulls together the severed and inverted turf so as to embrace the plant with the line of junction crossing the prevailing winds, or from north to south, taking care at the same time that the plant, when confirmed by the foot, shall not be set deeper than it stood in the nursery. In this method, if the holes be dug some weeks or even months before planting, the young trees will have a much better chance of success, owing to the aëration of the soil from the previous exposure. The expense of digging such holes varies from 6*d.* to 10*d.* per hundred, as where the soil is strong the pickaxe must be used to loosen it up, and this, with

the change of tools, occasions much delay. The business of depositing the plants must be done by day-labour, as to plant by the hundred will ever prove an ill-requited economy, from the temptation it holds out to slight so important a work. The above is a very suitable and safe method of planting both resinous and non-resinous trees, where the soil is light, or the surface rugged, which is the case in the great majority of instances; but for planting oaks and other deciduous trees in stiff clays and very hard soils, which will admit of the operation of the trenching-plough, it is more than probable that the extra expense would be very much more than repaid by the rapid growth of the plant; of this, however, more hereafter.

The distance at which trees should be planted out must depend upon the elevation and exposure of the situation; but, generally speaking, 4 feet is near enough for almost any situation, at which distance they soon afford each other shelter, and will yield some return at the first thinning. In lower and more sheltered places, however, I am inclined to recommend a distance of 5 or even 6 feet, in doing which I confess I am not uninfluenced by the dread of the neglect of timely thinning, the common and prevailing error of the management of plantations, and which is the more to be apprehended in situations where the plants grow rapidly.

During the operation of planting, great care should be taken that the roots of the plants be not exposed more than can be possibly avoided after they are removed from the nursery; the prevention of this is one of the principal objects of having the nursery near the ground to be supplied with plants. With this object, the planters should be supplied by persons employed in bringing them fresh from the nursery, or the roots should be covered with earth till the moment they are wanted. It is of the utmost importance to preserve the fibres of the roots from becoming dry. The business of planting should commence with the fall of the leaf, and be prosecuted as long as the weather continues open, and resumed as soon as the season permits in the spring, the advance of which will prescribe the suspension of the work. During the two or three first years the greatest diligence should be used to prevent the plants being whipped or injured by weeds.

In mixed plantations, and where the resinous trees are used for nurses, and intended to be removed, or to give way finally to oaks, chesnuts, &c., the latter must be planted at suitable distances, and care must be taken that they be not overtopped by the more rapid growth of their nursing neighbours, and that they rise with straight stems. To ensure the latter condition, such

plants as are stunted and branchy, which they are apt to be, should in the winter of the second year be cut off close to the ground, or to the last visible bud; this will cause them to send up one or more straight and vigorous shoots, the finest of which should be selected, and the others removed in the winter ensuing. I have seen the Spanish chesnut, after being so cut down, produce a shoot of 5 feet high. After this operation the root will have free open alburnum through which to propel the sap, instead of the stunted, hard, original stem, and the plant will make corresponding progress. Subsequent care must be taken to confine them to their upright course by the proximity of their nurses, and at the same time to prevent their being injured by being too much crowded.

Every person who has paid the least attention to any branch of culture must be aware of the advantage resulting from loosening the soil about the roots of plants, and the constant and strikingly beneficial effects produced by that operation upon their growth; and all cultivators of common intelligence are aware that this effect is owing to the free admission of air and moisture to the soil and the roots of the plants, and also the facility afforded to the latter of extending themselves in search of their proper food. If the practice be so beneficial to annual plants, whose roots are confined to a few inches of the surface of the soil, it must be applicable with stronger reason to those of a more durable kind, whose roots penetrate to a greater depth and take a wider range. Nurserymen, whose profit depends upon the rapid growth of their plants, invariably prepare their soil with great care by draining, trenching, and manuring, and during the progress of the plants cultivate it by repeated hoeings, for the admission of air and the moisture it contains to the soil beneath the surface, as well as for the destruction of weeds, well knowing the consequence of the neglect of these operations on the growth of forest-trees in their infant state. Farmers know full well the ill consequences of purchasing young cattle from rich districts to put them upon inferior pastures; and all observant planters must have noticed the corresponding ill effects of planting out trees from a well-managed nursery, upon a hard, bare, and uncultivated soil. Such persons must also have noticed the very great difference, in every stage of their growth, of trees of most kinds according to the accidental circumstances in which they were placed; whether growing in a hard, stiff, and almost impenetrable soil; or, on the contrary, in free sands and other loose soils; in hedge-rows of cultivated fields; in gardens and pleasure-grounds; in deep alluvial lands; or where they are constantly manured by cattle which resort to them for shade or shelter. In such situations

as the several last mentioned, the trees derive the greatest benefit from two sources, the permeability of the soil, and the abundant supply of every kind of food which they require.

When we attempt to assist Nature in her operations, we should surely bear in mind these instructive lessons which she everywhere presents to our observation. Our own maxims and practice in the nursery should be transferred to the sites to be planted, and a corresponding course pursued, as far as circumstances render it necessary or practicable, to carry them into effect. I have planted orchards upon most of the soils best suited to the growth of apple-trees, and have always found that those grew the fastest, where the soil has been of a loose but marly and calcareous nature; but the most promising orchard was in a field which had been, up to the time of planting, and was for some time afterwards, cultivated as a hop-yard. In the lias formation, where the soil has been moved to a considerable depth in taking out the thin beds of stone, it is observed that apple-trees thrive with much greater vigour in such situations than where the soil has not been so loosened. In adducing these proofs of the beneficial effect produced upon the growth of trees, by deepening and improving the condition of the soil, I by no means wish to contend that trenching is desirable or manuring practicable upon all soils indiscriminately, or even in the great majority of instances. In mountainous districts, for instance, where the rocks are thinly covered with a light siliceous soil, such as most of the transition and all the primitive series present, the trenching of the ground, even on such rare spots where it might be practicable, would be decidedly injurious, as on such soils the turf is for the most part needful to prevent the earth from being blown away by the high winds, and to preserve moisture; and the soil is already sufficiently loose for the due admission of air and moisture, and the extension of the roots of the plants. In lower situations, on the more recent strata, such as the new red-sandstone, the sand of the inferior oolite, the iron and green sands, those of the plastic clay, and some of the Bagshot sands, the soils are generally so loose as to require no preparation. Such soils are best adapted to the growth of larch and fir, which are less grateful for cultivation than other trees. I have planted extensively on most of the light soils, from those of the grauwacke to the greensand inclusive, without trenching and with entire success. In some of these plantations I have seen larch and Spanish chesnut make annual shoots of 3 feet. On such soils, therefore, previous expensive operations are needless, when not only the pine-tribe, but many valuable deciduous trees will thrive luxuriantly without. But the case is very different in extremely stiff clays and firm iron-bound gravels; on them plants often languish for years before they can

make any vigorous progress, and both reason and experience point out the causes of this condition of the plants, and the means by which it might be prevented. In soils of this kind, which are always very retentive of moisture, previous trenching and open draining are indispensable, and as they are generally destitute of calcareous matter, liming would be highly beneficial. In situations where manure can be obtained, a crop of potatoes may be taken previously to planting the trees, and another between the rows afterwards. The cultivation of these crops would be highly beneficial to the plants, and the greater part, if not the whole, of the expenses would be repaid. With such management the plants would thrive vigorously from the first, and their future progress would manifest that trees are not less grateful for the pains bestowed on their culture than other plants. In situations and under circumstances which render trenching and manuring either impracticable or unnecessary, open draining can never be dispensed with if the soil be wet or springy. I have seen plantations entirely fail on a sandy soil covered with peat resulting from the decay of heath-plants, which was of so peculiar a nature as to be more retentive than clay; while on adjoining land of the same kind, by adopting a proper mode of surface-draining, a plantation of which I had the management made greater progress than on the ordinary dry land in the neighbourhood. The peat, which in the former case destroyed the plants by its retentiveness of moisture, was in the latter rendered conducive to their rapid growth.

It is scarcely needful to mention that, before the commencement of planting, the ground should be thoroughly and substantially fenced against sheep and cattle, and that effectual means be taken to guard the young trees against the depredations of hares and rabbits. In all extensive undertakings drives should be laid out and levelled, by which a facility will be afforded for future inspection and management.

Thinning, Pruning, and Management of Woods and Plantations.

Next in importance to judicious planting is the subsequent management of trees, without which the most skilful previous operations will be rendered almost nugatory. The deplorable condition of by far the greatest part of woods and plantations presents an excellent negative example, and would lead to the conclusion that those who profess to manage them are not only ignorant of the first rudiments of the physiology of plants, but are equally destitute of the least power of observation and reflection. I have seen plantations which, for thirty years from the time of planting, had not been thinned at all, though the trees were only

four feet apart; and it is extremely rare to find a plantation of either firs or deciduous trees in which any regular and consistent system of thinning has been pursued; so rare, indeed, that I am sure I speak within compass when I state that not one in twenty exhibits proofs of judicious management in this particular. The same remark will apply to self-planted woods and forests, the owners of which, it would seem, with a few honourable exceptions, content themselves with such timber as unassisted nature provides for them, without any care and solicitude on their parts. This neglect is the more remarkable, as the appearance of a few well-grown trees of each kind, which by accident have stood at such a distance as to have attained their full and proper dimensions, and which may be seen almost everywhere, would suggest the proper course to be adopted. The least reflection on the actual condition of such trees would connect the ideas of a large full head and a thick stem, and lead to the conclusion that the branches and their leaves must in some way or other minister to the growth and increase of the trunk: the next conclusion would be, that they are quite indispensable to its increase; and pursuing the inquiry still further, we must arrive at the important fact that trees derive almost the whole of their substance from the air in which their leaves are expanded; and, lastly, that an ample access of light and air are necessary to the healthy discharge of their functions. All this has long since been fully proved by men who, without any other motive than the love of science, have given their minds to investigate the interesting phenomena of vegetable life. How little either science or observation have yet influenced the operations of the forester, the present condition of most of our woods and plantations sufficiently testifies. Before proceeding further on this subject, the reader is referred to the description given at the commencement of this Paper of the several organs of trees, and the parts they perform in the progress of vegetation; which, though brief and imperfect, it is hoped will be found sufficient for the purpose intended; namely, to enable him to form clear ideas of the extent to which the judicious interference of man, during the growth of trees, may be conducive to the production of the *greatest quantity of valuable timber*, and also of the ill effects of injudicious treatment or neglect in defeating that object. A clear understanding of this subject is not only necessary from the present state of timbered districts before alluded to, but also because some persons who have undertaken to direct public opinion in the management of timber-trees entertain the most conflicting opinions—for while one author recommends the cutting away or thinning out a large portion of the head of a tree, in order to promote the production of timber, another treats the subject both of thinning and pruning as scarcely needed, if not injurious.

It is presumed, however, that a due consideration of the nature of the organs of trees and the functions they perform will be sufficient to prove that both these views are almost equally erroneous.

If a considerable portion of the roots of a tree be cut away, the consequence of that curtailment is a partial or imperfect development of the leaves in the ensuing spring: on the other hand, if a large portion of the branches be removed, the tree is observed to make considerably less progress in the following summer. In either case the stem will not increase so much in size as it would otherwise have done. These are well-known facts; and from what has been stated of the uses of the different organs of a tree, such consequences must necessarily result. In the first instance, there was a deficient supply of ascending sap, owing to the loss of roots and fibres; and, in the second, less sap was elaborated, owing to the diminished number of leaves, and consequently less wood produced. If the whole of the branches be removed, most trees die; and the same effect follows if the whole of the roots be cut off; and though some trees will put forth fresh roots and develop new buds and shoots, the growth of the stem is so much retarded as to become scarcely perceptible, and will make but little progress until the new roots and branches are considerably extended.

If a tree be planted in an open but sheltered spot, and in a favourable soil, it will, in the unrestricted progress of its growth, assume all its natural proportions of roots, stem, branches, and leaves; and, considering the means by which its increase is effected—that is, the reciprocal action of its roots and leaves—it is impossible that any interference on the part of man, in the way of pruning or cutting off part of its branches, can have the effect of accelerating its progress; but, on the contrary, it must be evident that any such interference will have the contrary effect. Every branch contributes to swell and increase that part of the trunk beneath it, and serves also to extend the roots, by which more sap is supplied, and the increase continued. Accordingly, in tracing the stem from the top downwards, we observe that its dimensions are enlarged at the junction of each individual branch, and in proportion to the size of the branch; thus producing that general tapering form which trees exhibit. If another tree, of the same kind, and in all respects having the same advantages, be subjected to the management of the pruner, whether he adopt the ignorant and absurd plan above alluded to, of removing all the large branches in every part of the tree, or the more moderate and rational method of gradually taking off the under branches as the tree aspires, it must be most evident that the increase of the stem must be retarded, and that in proportion to the extent

of the dismemberment; and at the end of a given number of years, though it will have a cleaner stem, it will be found to contain less timber, both in its trunk and branches, than that which was left to grow without restriction. There can be no mistake in this view of the subject; and yet an eminent author, who wrote ten years after the publication of Mr. Knight's admirable papers on the Physiology of Plants, asserts that "pruning not only improves the form, but increases the size and general weight of a tree:" an assertion which more correct observation would doubtless have prevented him from making.

If the object be to produce beautiful trees, either singly or in groups, for the purpose of ornament or picturesque effect, Nature must be left to her own course, and we can only aid her by such small service as that of carefully removing a broken branch. But as the principal object in the cultivation of forest-trees is to produce upon a given space of ground not the most wood merely, nor ornamental effect, but the greatest quantity of clean, straight, valuable timber, we must make a compromise with nature, and recourse must be had for that purpose to judicious and timely pruning where trees stand alone, as in coppices and hedgerows, and thinning and pruning in plantations and where trees rise thick together, as in natural forests.

Though most planters and writers agree upon the necessity of thinning and pruning, great difference has prevailed as to the extent to which it should be carried, and no reasonable rule has been laid down which may serve even as a general guide to the practical forester. Pruning must be necessarily confined to the early stages of the growth of trees; for however desirable it may be to have clean timber, it is no less desirable to have it sound also; but if large branches be removed from a tree, however skillfully it be performed, an injurious scar will appear when the timber is cut open for use. To avoid this evil, no branch should be removed which would expose a surface of more than $2\frac{1}{2}$ or 3 inches in diameter: a wound of the size mentioned will soon be healed over, and will scarcely present a visible scar when the tree is cut open only a few years afterwards. In pruning trees that stand alone, the first attention should be directed to the top, and if there be a formidable rival to the leading shoot, it must be checked by taking off its head; and if there be any strong branch which is producing a powerful diversion from the main stem, it should also be checked in the same way. The lowest of the side branches may then be removed close to the bole or stem, which is most conveniently done with a small saw; the wound should then be carefully pared over with a knife, so as to leave the lips of the cut quite smooth. This operation may be repeated every two or three years, always taking care that the head *shall occupy full*

half of the entire height of the tree. With this proportion, trees of all kinds will maintain a vigorous growth, and produce ultimately fine timber. If the first pruning has been deferred too long, it is not prudent to pursue it up to the prescribed point at once, but to do it in two successive years, which will prevent the tree from throwing out numerous side-shoots, which it is apt to do when too many branches are removed at once. If young trees stand so near together as to prevent each other from having a free scope for the growth of their heads, the redundant trees should be timely removed; and this must be repeated in after-years as the heads require a wider space. These directions will apply to all deciduous trees, whether standing in hedgerows, coppices, or larger woods. The most proper season for pruning is during the winter months to the end of February. The commencement of thinning plantations must depend upon the rapidity of their growth, and will vary from eight to fourteen years from the time of planting. In mixed plantations of oaks, ash, Spanish chesnut, and beech, with resinous trees for nurses, the utmost attention must be paid to preserve the former from being overtopped by their vigorous nurses, during every year of their growth, and this may be effected by either shortening the boughs of the nurses, or, if needful, by removing them. At the first thinning, half the total number of trees may be removed, with perhaps some exception in such parts where the trees are less prosperous. By thus cutting them down in rows, the labour will be more easily performed, both of cutting and carrying away the poles. The spray should be cut off, and left where the tree falls. The number of trees removed at the first thinning must, however, depend upon the actual state of their branches, reference being always had to the rule laid down as to the relative proportion of the head and stem. Half the remainder may be gradually removed, at from three to five years after; thus leaving only a fourth of the original number standing at the end of from fifteen to nineteen years. From this time the business of thinning may be pursued every winter, attending to those parts of the plantation first where the trees grow most rapidly, and with this object always in view, that the branches of none of the trees, and especially those intended finally to remain, be so injured by their neighbours as to prevent their retaining *a perfectly healthy head of full half their entire height.* This is the great rule and guide to be observed in thinning, and will stand in lieu of all others, as to the time and manner of doing it. The business of thinning will generally be completed in about thirty years from the time of planting, when the trees will stand at their proper and ultimate distance for timber. During all this time the branches whose leaves have been killed by the exclusion of light must be removed close to the

stem; which, if the thinnings be well-timed, will perhaps be all the pruning that the resinous trees will require, except the occasional shortening of a false leading shoot, to prevent trees from forking; taking care that the rule with regard to the quantity of head be observed as nearly as possible. The oaks, chesnuts, &c. will require more attention, and should be treated in the manner previously stated for such trees. The final distance of larch and other resinous trees should not be less than 16 feet; and oaks, &c. will require nearly double that space. This must be considered at the time of planting, and borne in mind during the operation of thinning. As all plantations are objects of taste, it will be desirable so to manage them as to have the most agreeable effect. The outsides of most plantations present a hard compact outline, or verdant wall. To avoid this disagreeable effect, the thinning on the outsides and along the drives, should be commenced so early as to allow a double rank of the *final* trees to take their full natural growth, by which depth and variety would take place of the too common monotony, without any material sacrifice of ultimate profit. With regard to the bulk of the plantation, as well as to woods in general, the rule I have given for regulating both the progressive and final distance of trees is the best that I can suggest, and it is the result of long and attentive observation of the actual condition of trees so circumstanced. The very intelligent author of the article on planting in the 'Library of Useful Knowledge' states that there is a beech-tree in Woburn Park which contains 400 feet of timber, the stem of which measures 50 feet to the boughs, and the head 50 more; and an oak, containing 492 feet of timber, whose stem measures 50, and the head 40 feet: both sufficient proofs that trees will attain great magnitude with the proportion of head suggested.

I cannot quit this subject without strenuously insisting upon the most constant and careful attention to it in the progress of plantations—the neglect of which yearly inflicts enormous loss both upon individuals and the public; an opinion in which I am sure I shall be borne out by a survey of the timbered districts of the kingdom by any enlightened cultivator of trees. A more pressing need has long since taught the gardener and the farmer the necessity of giving each plant a suitable space to enable it to produce the desired result, and the proper distances are assigned to all the plants of our gardens and fields; but either the more easy circumstances of the landed proprietor, or the comparative remoteness of the result—perhaps both combined—have, generally speaking, deprived trees of the same reasonable management. The maxims of the garden and the cultivated field have not been carried into our woods and plantations, at least in a sufficient degree; and the condition of most of the latter would lead

to the conclusion, that the intention of the proprietor was to produce a crop of poles, and not timber, if the time they are often suffered to stand did not refute the notion. I have frequently witnessed the effect of long neglect of thinning plantations of oak, in soils and situations capable of producing trees of the largest dimensions, where, from the trees having been allowed to stand within a few feet of each other for perhaps sixty years, their tall attenuated stems, of 40 or 50 feet bore, on their tops small bushy, unhealthy heads of almost vertical boughs, and the corresponding weakness of their roots, made them liable to be swept down by every rough blast of wind.

The effect of relieving such trees by removing a portion of them, a proceeding in such extreme cases always hazardous, was in one instance very remarkable; obstructed Nature seemed to rejoice in her liberty, and the before-naked stems sent out innumerable shoots through their whole length, and the heads bore fruit, which they never produced before.

Such cases are much too common. The Scotch Laird's injunction to his son, "to be aye sticking in a tree," was excellent advice as far as it went, but was very imperfect: he should have enjoined him at the same time to be aye looking after it, and taking care that those which he himself had planted were not spoiled by neglect. It is no argument against the careful and judicious thinning and pruning the trees in plantations and even of natural forests, that we get fine timber from the continental forests which have had no such advantages. The trees in such forests are very differently circumstanced from those in plantations, as the latter are all planted at one time, and are equal rivals of each other; whereas in the former case they rise at different times, whereby some obtain an ascendancy, and are enabled to spread forth their branches and produce fine timber. The number of these, however, is comparatively very small; for I have been assured by an experienced lumberer, as the wood-cutters are called, that in the Canadian forests, not above one in ten thousand is found to be worth cutting for transport to this country.

The care of man, therefore, in the management of growing timber, may be made as beneficial as in any other kind of cultivation. Instead of one tree in many thousands, every tree in a well-managed plantation will be rendered valuable.

In thinning neglected plantations the greatest caution must be exercised to prevent a too sudden exposure, which would soon be destructive of the whole. The outside trees should not be touched; and within, the most stifled and injured of them should be selected first, and as those left standing gained strength more might be removed.

Though the profit of planting is unquestionably great, as may

be proved by numerous instances both of the sale of thinnings, and in some cases, of the entire plant of half-grown trees, yet we have no account of the total produce of any one plantation which has been brought to maturity under good management, and the timber finally sold. Indeed, since the commencement of planting upon a large scale in this country, time has not elapsed sufficient for so complete a proof. Much important light might be thrown upon this subject by authenticated reports of the plantations of the Dukes of Athol, Portland, and Bedford,* and the Earl of Leicester, which have now been in progress a sufficient number of years to admit of correct conclusions on this head being drawn from them. The success of such great examples, when known, would besides have the effect of extending this beneficial branch of cultivation.

The great experience of the late Duke of Athol, by far the most extensive planter in the United Kingdom, entitles him to the highest confidence. In the reports of the Highland Society, are numerous extracts from his Grace's memoranda respecting his plantations at Dunkeld and Blair Athol, which exhibit in the most striking manner the immense increase of property that might be effected by planting. The Duke states, that the land upon which his plantations were made was not originally worth more than a rental of 9*d.* to 1*s.* per acre, but such was the effect of the amelioration of climate and the improvement of the soil produced by the trees, that at the end of thirty years the pasture under the trees was worth 10*s.* per acre per annum, as he proved by a decisive experiment. The rapid growth of larch timber, and the produce of some sales from these estates, have been already noticed in a former part of this paper. Encouraged by such experience, the Duke planted during the latter years of his life 6500 acres with larch only; the last of these plantations were that

* The proof-sheet of this Paper having been forwarded to his Grace the Duke of Bedford by Mr. Hudson, the following memorandum was received from Mr. Bennett, his Grace's steward:—

“A plantation of fir, chiefly Scotch, with a few larch, was made about the year 1780. Five years afterwards it was found in an indifferent state, and was filled up and partially replanted. The soil is a black, heathy sand, and was when planted of little or no value, producing only a little heath and some furze. The average size of the thinnings were,—

In 1802	. . .	1 cubic foot each.
1812	. . .	2 feet.
1822	. . .	8 feet.
1832	. . .	9½ feet.

“In 1841-2, six acres were entirely cut down; and the trees on the remaining part averaged 21½ feet—many of them containing 30 feet, and upwards, to 50 feet of timber. Thirty-six acres of the same plantation are now standing, with a full crop of growing timber. The six acres which were cleared were replanted with oak, ash, and larch.”

of Loch Odie of 2959 acres, and Loch Hoishnie of 2231 acres. The expense of fencing and planting the former is stated at 16s. 8d. per acre, and that of the latter 15s. per acre. They were planted with seedlings, and by means of the diamond-dibble as before described.

The value of the thinnings of plantations must, in a great measure, depend upon local circumstances, and therefore neither the estimated value nor the actual money obtained for them in one place will be realised in all. The thinnings of Scotch fir planted by the Marquis of Bath upon land not worth more than 2s. per acre, paid more per acre per annum than the best land upon his estates. The trees of a plantation of larch, Scotch, and spruce, standing 10 feet apart at the age of sixteen years, no notice being taken of the produce of previous thinnings, was estimated at a value which gave an annual rental of 4l. 14s. per acre per annum upon land originally worth only 8s. Though these may appear high returns and estimates, the actual proceeds of plantations often far exceed them in particular situations. A gentleman in Bedfordshire lately sold to a Railroad Company the entire crop of four acres of a mixed plantation, which had been planted thirty-five years, for 400l. per acre. These trees grew upon land not worth more than a rental of 2s. 6d. per acre. This return amounts to more than 11l. per acre per annum, to say nothing of the previous thinnings. Disregarding all extraordinary calculations and results, such as those above mentioned, and estimating the thinnings far below my own experience and that of all persons whom I have consulted, the entire crop of each of three separate acres of larch, including the previous thinnings, and taken at the end of twenty, twenty-five, and thirty years, I calculate would produce the gross sums respectively of 51l., 119l., and 246l.

Mr. Monteith, in his introduction to his '*Forester's Guide*,' gives a detailed calculation of the planting and management of 100 acres, chiefly with oak, and states the clear balance of profit at the end of forty years, at 41,000l., after paying a high rent and unusually heavy charges.

Mr. George Sinclair, who has distinguished himself by his knowledge of both field and forest culture, and upon whose accuracy and judgment the greatest reliance may be placed, calculates that the thinnings on an acre of land of the value of 5s. to 10s., planted with a mixed portion of larch, beech, pines, hazel, birch, and oak, the latter with a view to the growth of naval timber, will at the end of ten or fifteen years, according to local circumstances, repay the average expense of planting, rent, and management during that period, together with compound interest at 5 per cent.; and he estimates the profits of the future sales as follows:—In thirteen years, or twenty-three years' growth, 24l.

per acre; in thirteen years more, or thirty-six years' growth, 39*l.* per acre; and after that, a triennial profit of about 12*l.* per acre, until the oak left standing may be supposed to be fit for the naval yards, and worth, at the present prices, 264*l.*

The following estimate of the expense of purchasing, planting, fencing, and subsequent management of an acre of poor mountainous land with larch, and also of the returns during a period of sixty years, was drawn up with a view to promote the formation of a society for the provident investment of money:—

Estimate of the Expenses and Returns, during Sixty Years, of an Acre of Land planted with Larch, Compound Interest being calculated both ways.

<i>Expenses.</i>	Simple Expense.			At Compound Interest in Sixty Years.		
	£.	s.	d.	£.	s.	d.
The purchase of an acre of land . . .	8	0	0			
Fencing and planting	2	0	0			
	<hr/>					
	10	0	0	186	15	10
Expenses of management at 10 <i>s.</i> per acre per annum for sixty years, worth in present money	9	9	3	176	15	4
Insurance, 10 <i>s.</i> per acre, for twenty years	2	2	0	39	4	6
	<hr/>					
	£21	11	3	£402	15	8
	<hr/>					
<i>Returns.</i>						
	£.	s.	d.	£.	s.	d.
1st. Thinning at the end of fifteen years, 1361 poles at 3 <i>d.</i> each	17	0	3	152	17	1
2nd. Thinning at the end of twenty years, 680 poles at 6 <i>d.</i>	17	0	0	119	13	7
3rd. Thinning at the end of twenty-five years, 340 poles at 2 <i>s.</i> 6 <i>d.</i>	42	10	0	234	8	7
4th. Thinning at the end of thirty years, 140 poles at 10 <i>s.</i>	70	0	0	302	10	9
Final crop of timber at the end of sixty years, 200 loads at 3 <i>l.</i> per load	600	0	0	600	0	0
Pasture of the grass, thirty years, at 8 <i>s.</i> per annum	26	10	0	26	10	0
An acre of land at improved value	10	0	0	10	0	0
	<hr/>					
	£783	0	3	£1446	0	0

The following tables exhibit in a conspicuous manner the advantage to be derived from vesting money in planting. No. 1 shows the value of 100*l.* at successive periods of five years, at compound interest merely; and No. 2 shows the value of 100*l.* at corresponding periods vested in planted land. The difference between the corresponding sums will show the gain at that time:—

	No. 1.			No. 2.		
	£.	s.	d.	£.	s.	d.
In 5 years	100	0	0	358	11	1
10 „	127	12	7	457	16	0
15 „	162	17	9	584	5	0
20 „	207	17	9	745	14	0
25 „	265	6	7	957	3	0
30 „	338	12	0	1214	14	0
35 „	432	3	9	1550	7	0
40 „	551	12	0	1987	13	0
45 „	704	0	0	2525	7	0
50 „	898	10	0	3223	2	0
55 „	1146	4	9	4113	12	0
60 „	1463	11	2	5250	3	0
	1867	18	4	6702	0	0

The amount of 100*l.* at compound interest merely, will at the end of 60 years be only 1867*l.* It will appear by referring to the calculation, that 21*l.* 11*s.* 3*d.* expended in the purchase and planting an acre of land, will produce at the end of sixty years 1446*l.*; therefore 100*l.* will in the same period amount to 6702*l.*, which sum is worth in present money 358*l.* 11*s.* 1*d.*, the sum with which Table No. 2 commences. These tables are calculated with sufficient accuracy for the purpose intended, and, together with the estimate of the produce of an acre of planted land upon which they are founded, place in a strong light the great profit to be expected from planting, even after making every allowance that the most scrupulous caution can suggest.

Plantations in elevated and exposed situations should always be in large masses, by which plants afford each other more shelter, and the expense of fencing is most materially diminished. With regard to the shelter afforded by plantations to the adjoining land, it might safely be affirmed that if one-fifth of a very exposed estate were planted in such a manner as to afford the most effectual shelter, the climate of the remaining land would be so much improved, as to render it more valuable than the whole was before. The improvement effected by a larch plantation is most strikingly manifested by the following memorandum of the Duke of Athol, inserted in the Reports of the Highland Society:—"I ordered this month (May) 150 head of cattle to be turned out into the larch plantations at Blair till the grass in the parks got up—thirty years back the same hill would not have afforded pasture for ten." This was the combined effect of shelter and the improvement of the soil. As trees derive almost the whole of their substance from the air, a proprietor of plantations has the agreeable satisfaction of reflecting that by planting he has created a condition, an infallible means, by which the common unappropriated bounty of Nature, the treasure of the viewless winds, is

made his own, and daily accumulates in substantial and beautiful forms upon the spot which he has assigned to them ; and that while he has enriched himself by one of the most rational of all pursuits, he has adorned the face and increased the resources of the country.

When, after traversing a dreary expanse, one suddenly chances upon a country enriched with groves and plantations, affording shelter to cultivated fields, and creating a garden in the wilderness, an involuntary sentiment of respect rises in the mind of the observer towards the person who raised and bequeathed to his successors and to mankind, so beneficial and interesting a memorial of his generous and provident exertions.

To the honour of our country, we have many noble examples of this kind ; and if they were followed by all who possess the means of prosecuting such interesting works, a large portion of our peasantry would be employed at a period of the year when they are often starving or burthensome to others ; our climate would be improved ; the whole country would assume the appearance of a magnificent garden ; and at no distant period we should be rendered independent of foreign states for the supply of a material, which contributes more than any other to sustain the commerce, and secure the safety of the empire.

XXI.—*On Wheat.* By C. HILLYARD, of Thorpeland, near Northampton.

[From the forthcoming Edition of his *Work on Practical Farming.*]

DESIRABLE as it may be to grow wheat, it should never be sown on land that is not in a fit state for it. It is the general opinion that wheat, like other grain, should only come in a successive course of cropping, not oftener than once in four years—some say six, seven, or eight. I am not satisfied, on good soils, well cultivated, that good crops of wheat could not be obtained every other year. I have known good clay-land, for a length of years, produce alternately good crops of beans and wheat ; and therefore think it possible that good crops of wheat, sown in November, on good loamy soils, might be obtained after turnips or mangold-wurzel have been drawn off. Probably but few experienced farmers will join me in this opinion ; and as mine is only a speculative one, I do not mean to advise inexperienced farmers to try it, excepting it should be on a small scale. I will appropriate two or three acres of my farm to try the experiment : the land thus appropriated will produce more manure than is necessary to

be applied to it ; this must make the experiment not to be called an unwise one.

The best preparatory crop for wheat, on most lands, is clover of one year's growth, the decayed roots of which furnish much nourishment for the growing wheat ; but good crops may be obtained on good loamy soils, sowed in November, after turnips or mangold-wurzel.

Many occupiers of strong land still adhere to the old custom of ploughing in their seed-wheat on a summer fallow. It is natural to suppose they must find it answer, or they would not continue the practice, though it is now generally thought that on such land drilling would be better ; for thus all the seed is put in at proper depth and distance ; besides which, wheat ploughed in cannot be horse-hoed, or so well hand-hoed. Wheat now generally follows clover ; the seed drilled in across the ploughed furrows : and if the young wheat escapes the ravages of the wire-worm and other grubs, which it is the most likely to do when the land can be laid solid, good crops are obtained ; but as a sandy soil, or sandy loam, is not likely to be firm, it is my opinion, from experience, that on light soils the best method of putting in seed-wheat is by the use of the presser that follows two ploughs, presses hard down the turf in the seams of each furrow, and thus forms drills into which the seed regularly falls on being sowed broadcast, when the wind is not high. The machine which forms the drills and deposits the seed at the same time is best ; for the seed then is more equally laid in the drills ; but the difficulty is to get the seed, swollen from brining and liming, to run regularly down the pipes. The seed in the pressed drills which are wide at bottom is more divided, and has more room to grow than it has when put into the land by a drill. Some think the presser makes the drills too hard at bottom for the young shoots to penetrate ; although the idea appears somewhat plausible, the fact is not so.

Two of my wheat-crops in 1841, like others of this neighbourhood on sandy loamy soils, went off in the spring so as to be very bad at harvest. It is not only sustaining a loss, but it is somewhat mortifying to have one's land seen by persons travelling on the turnpike road, full of gaudy poppies and other weeds, as it is sure to be when crops fail. One of the wheat-crops was on a one-year's clover-ley, the seed drilled in October : the other after turnips, the first week in December. On first discovering the thinness of plant in both the crops, I attributed it entirely to the ravages of the wire-worm, but afterwards was convinced of being mistaken as to the one on the clover-ley. In this there was no appearance of thinness of plant when the snow went away. Afterwards there was, for some time, severe frost with very high wind, without any snow on the ground ; thus the mould on the highest

parts of the field being turned into dust, was blown away, and the roots of the wheat left so bare of covering as to be killed by the frost. On the low ground of the field, and by the hedge-sides, which were protected from high winds, trodden down hard, and where the wire-worm is scarcely ever found, the crop was good.

This field was ploughed in the autumn by teams contending for our parish ploughing prizes. Being in Scotland at the time, I doubt if the seed was drilled in so deep as 4 inches, as I have long desired that my wheat should be on those parts of my farm where the soil is chiefly composed of sand. The ploughing was done in that way which is generally thought to be the best; that is, the furrows were laid much on edge, but which I do not like when the seed is to be drilled in. When it is sown broadcast it is right, because the harrows then catch plenty of mould to cover the seed; but when the seed is to be drilled, I feel assured that on land like mine it is best to have a thick furrow ploughed, and so turned over to lie as flat as possible; thus, when the seed is deposited in the earth by the drill, the land will be quite solid, which is so necessary for the chance of a good crop of wheat.

Instead of the land of my clover-ley crop of wheat lying solid, from the manner in which it had been ploughed and managed, it lay so hollow that, in walking over it about Christmas, it sank several inches at every footstep: this was bad, but could not be remedied, for the roller could not then be used, nor would it then do to feed a flock of sheep on it. Daily driving a flock over it might have done some good. There was, I find, another thing against my having a good crop—the land was ploughed when *quite dry*, which a clover-ley, intended for wheat, ought never to be.

I used the presser in putting in all my clover-ley wheat in the autumn of 1841, and never reaped better crops than in 1842. But the best was, from a favourable season, after turnips and mangold-wurzel sown the first week in February, the weather in November not being favourable. As there had been about 33 tons of the mangold-wurzel and 23 tons an acre of the turnips carted off, the wheat, as may be supposed, was the heaviest crop where the turnips had grown, excepting where a great quantity of mangold-wurzel leaves had been ploughed in. I have for many years sown wheat in November, after swedes and mangold were carted off, and also after swedes eaten off in February, and generally, but not always, with good success, such late-sown wheat being in some seasons liable to mildew, when that which had been sown in the autumn has escaped. Several of my neighbours, who never attempted it before, sowed in February, 1842, part of their land after turnips, and obtained good crops.

Should the land of a clover-ley have been so much neglected

as to have in it a great deal of couch, it should be twice ploughed, as much of the couch got out as possible, carried off, and thrown into a heap, with a good portion of lime: thus good manure will be obtained for some future crop. A more than usual quantity of seed-wheat should be deeply drilled in. If put in with much couch, the crop must be weak, from the couch absorbing the chief part of the nourishment which the land possesses. If sandy loams are clean, they need not be very rich to produce good fair crops of wheat. All occupiers know the time best suited for sowing their land. I like to begin as early as possible in October, that I may have none sown too late; but it sometimes happens that the later sown turns out the best. It should, however, be borne in mind that after late sowing there is late reaping, and less dependence on the weather to harvest the crop in good condition; besides which, late-sown wheat is more likely to be injured by grubs.

Occupiers best know the quantity of seed-corn to be sown per acre on their land. It is advisable to sow as much as the land will bear, without producing too great a bulk of straw; on my good loamy soil I never sow more than 3 bushels per acre.

For security against a severe winter seed should be deeply drilled in. Frost cannot kill the blades of wheat, if the roots are secured under a good covering of mould. There were great complaints in the spring of 1838, that a great portion of the wheat-crops were at that time very thin of plant, and that many fields had been ploughed up. Mine were never finer, and I feel satisfied that had other persons' seed been drilled in 4 inches deep, like mine, there would not have been such complaints of loss of plant. I, then, could show proof for my assertion. In one of the bouts of the drill, in consequence of seed enough not being put into the machine, for 40 yards no seed had been deposited. On this being discovered, drills were made with a hand-hoe, and corn put in. This, which was put in about 2 inches deep, came up much sooner than the other put in 4 inches deep, and looked best till Christmas; but, from the frost getting to the roots of it during the severe weather we then had, every root went off in the spring.

The Egyptian is the most productive of all wheat, but the coarsest. The best prospect of a good yield in a wheat crop is to see the straw bright and reedy, not flaggy, with an ear of fair length well filled out, which it seldom is if very long. Well cultivated good clay soils produce wheat of the finest quality; loams a greater quantity, but not of equal quality. There are soils, composed of a mixture of loam and clay, with small pebbles, which will bear excellent turnips, and cannot, like some other soils, be too highly manured, to bear wheat of a good quality.

Mr. Sewell, of Bookham, Surrey, and Mr. Fisher Hobbs,

Essex, whose white and brown wheats were selected for trial at Oxford in 1838, having each been kind enough to give me a bushel of their wheat, I had them dibbled in, with five other bushels of different kinds, namely, the brown lammas, grown at Burwell, Cambridgeshire; the clover, a brown wheat; the golden-drop; the Whittington, and my snow-drop white wheat; on seven measured half-acres, after mangold-wurzel. The produce was as follows:—

No.	NAME.	Bush.	Good.	Inferior.	Weight per Bushel.	Value per Quarter.	Per Acre.		
							Quantity.	Value.	
1	Essex Brown . . .	20	19	1	lbs. 64	64s.	Qrs. Bush.	£.	s. d.
2	Surrey White . . .	18	17	1	64	66s.	5 0	15 17	0
3	Brown, called Clover	20	19½	½	63½	63s.	4 4	14 14	0
4	Snow-drop White . .	19½	18½	1	63	64s.	5 0	15 13	6
5	Burwell Brown . .	22½	22	½	63	63s.	4 7	15 9	0
7	Whittington White .	18	17	1	62	62s.	5 5	17 12	0
							4 4	13 16	9

From the seed of the golden-drop being defective, there was not above half a crop; therefore no account was taken of it. It is in general productive, but of less value than most other kinds. The Whittington produced the most straw, but neither this, the golden-drop, nor snow-drop is likely to answer cultivating.

Although I do not approve of dibbling for general practice, yet, in order to show exactly the small quantity of 2 bushels per acre, I had the seed dibbled into holes 8 inches asunder. The winter was favourable for late-sown wheat on dry land, still if my experiment had been made on a clover-ley, and the sowing six weeks earlier, each kind would probably have produced more, and although the quantity of each was good, it possibly might have been better.

The result of this experiment strengthens the opinion I have long entertained, that the brown lammas wheats, such as the Burwell and the clover, are best suited to loamy soils, and for general growth in this county; besides which, in every market in the county it will always fetch a higher price than the white.

In Mark Lane it is the reverse of this, therefore the white may answer best to those growers whose grain is sold there, and more likely so if their soil is a strong clay or chalk. It is thought that if any description of white wheat were sown year after year on our sandy loams, it would, in the course of time, become brown.

A greater quantity of wheat is now produced per acre than formerly, by greater attention being paid in selecting seed from the best and most prolific kinds; and by close examination into

growing crops many new and valuable varieties are likely to be obtained, and thus there will be wheat best suited for every description of soil. The public are greatly indebted to Colonel Le Couteur for giving the result of his experiments made as to the produce and value of many varieties of wheat; but these experiments carried on in the Isle of Jersey, cannot be satisfactorily conclusive for the midland or northern counties of England. It does not, in my idea, add to the value of any kind of wheat that it produces an extra quantity of straw, and thus takes an extra quantity of nourishment from the land; besides this, a greater price must be given for the threshing, and there is a less chance of its being cleanly done.

Besides being a serious loss, it is mortifying to have a crop of growing wheat that, from good management, had a most promising appearance, spoiled by grubs. It is difficult to say what is best to be done in such a case; the crop cannot be restored, and it is impossible to stop the progress of under-ground ravages, for that which would kill the grubs would kill all the corn remaining on the land. When the crop is attacked by slugs above-ground, nothing will do so much good as slaked lime sown over the crop before sunrise. Some years ago, late in the spring, we discovered that there were an immense number of slugs in a good full crop of my wheat. Cabbage-leaves were placed at some yards' distance all over the crop. After their night's feeding, the creatures, which were snails without shells, took refuge from the sun on the under side of the leaves, from whence, by shaking over baskets every morning for about a fortnight, 2 bushels of grubs were collected. Turnip-leaves will do, but not so well as cabbage. Seldom have the wheat crops on strong land been so much injured by the grub as in December, 1841; consequently, seldom on such soils have the crops appeared so bad as in April, 1842. On examination into a crop, I found a great portion of the grain that had been sown, with the inside eaten out. All the snail tribe like a clay soil; sand does not suit their slimy coats: the wheat on the loamy soils never looked better. Under-ground ravages cannot be stopped; if the root is eaten, the plant must die; when the blade only has been eaten, fair crops, though somewhat later, may be expected. In those parts of a wheat-field where in March or April there appears to be scarcely any crop, such parts may successfully be filled up by transplanting in moist weather: therefore on land where wheat is liable to be eaten at the root by under-ground grubs, it may be well to have some part of the field sown with a double quantity of seed, to furnish plants if wanted; if not, to be thinned by hoeing: or to sow a piece of land to be entirely a seed-bed. A writer on agriculture recommends all wheat crops to be obtained by transplanting in spring. Although

it is well known that wheat will bear transplanting, it cannot be expected that any occupier of a farm of any extent should adopt such a system of raising his wheat crops. Where the whole crop has been eaten off, and it is too late in the season to sow other grain, or the land is too strong to sow turnips, the best way to prevent such ravages another year is a good dressing of salt, or the ammonia from gas-works. Attempts to make up a thin crop seldom answer expectation; different means should be tried on the different kinds of land, and according to the time at which the injury has taken place. On strong land, if not too late in the season, dibbling in beans is likely to answer, for the grub will not destroy them. Spring wheat or barley is likely to be eaten. When on my turnip soil I have had part of a crop eaten off, I have sowed by my long machine-box a thin sprinkling, a pound an acre, of turnip seed, and have had it hoed in; these turnips I have found most useful for lambs before penning them on a turnip crop; and the growth of these turnips lessens the quantity of weeds that would come up.

Pressure by rolling or folding, or both, after sowing on light land, does essential service; also early sowing, and eating the young blade closely and evenly down by penned sheep, giving them in pens the tops of turnips or mangold-wurzel. But on light soils in my opinion there is no way so good for putting in seed wheat as with the presser; and as it is not possible to make such soils too solid for wheat, it would be well, should the weather be favourable, to roll after the seeding, and afterwards drive a flock of sheep several times over the land.

It may so happen that crops of wheat escape smut without any preparation of the seed to prevent it; in these days, scarcely any one runs that risk, but all make use of some preventive. Mine for many years has been to steep the seed in brine that will swim an egg, drying it afterwards with slaked lime. A solution of quick-lime and water poured whilst hot on the heap of seed corn, turned over, and thus lying twenty-four hours, is a pretty safe preventive. There is no necessity for running the risks of accidents, as there always must be in the use of such deadly poisons as arsenic. An intelligent farming acquaintance says it is best to sow wheat which was cut before it was ripe; that such seed has more nourishment in it for the infant plant. Such grains surely cannot produce such strong healthy plants as ripe grains. The infant plant gets its first nourishment from the decomposed parts of the grain. A plump ripe grain surely must afford more nourishment for it than an unripe and consequently thin one.

The generality of the crops of wheat look yellow in the month of May; this is called *maying*: if a blade of wheat is pulled up in April, there will be found at the root a part of the seed grain

from which the root is receiving some nourishment: if it is examined in May, it will be found that the whole of the seed has been absorbed, and that the root has then the earth only for its nourishment: thus being deprived of its parent support, it feels this loss for a time, and shows, by the blade looking yellow, that it is not in so vigorous a state as it had been. This is given only as a supposition.

One who is thought to be a good farmer says he sows his tailing wheat, that is free from seeds of weeds, and that his produce is as good as if he sowed his plumpest best grain: but it must surely be safest to sow the best seed. Thin grains of corn come from ears which by some means have not had their full nourishment from the earth. Mildew, in most cases, in my opinion, is caused by the plant being too luxuriant, the root absorbing from the earth more nourishment than can get through the straw to the ear; the straw, therefore, bursts, and the juice exudes, turns the straw black, and renders it so callous that it is incapable of conveying a proper supply of nourishment to the ear; this makes the grain thin and poor; but such seed is not more likely than fine grain to produce a mildewed crop. When the straw is much affected, it should be cut, although unripe. For these few years past we have not been much troubled with it; but our good sandy loams, which produce luxuriant crops, suffer more frequently from it than the strong clays, or weaker and poorer soils; and I believe there is no preventive. I believe it to be a fact, that a barberry-bush growing near wheat will cause mildew. Where a dunghill has lain in a field, the wheat, growing very luxuriantly on that part, is often mildewed. There is a red wheat with a white chaff grown in this county that will not, it is said, mildew. It never did with me; but when I grew it, I do not think we ever had a mildewing year.

Wheat is expected to be ripe in six weeks from its blooming. Should the weather at that time be cold and boisterous, reasonable doubts may be entertained of there being good crops. The deficiency of the crop of 1838, I feel satisfied, arose from there being bad weather at the time of blooming; for, having had wheat brined in January to sow five acres after Swedish turnips, but which, from frost setting in, I was not enabled to sow till the 1st of March, this wheat blooming a fortnight later than my other crops, and in finer weather, proved much the best crop I had that year. In many parts of the country, on account of the extreme wetness of the autumn of 1839, a great deal of the strong wheat land could not be sown till February, 1840; at which time my opinion was asked by several farmers which would then answer best to sow, the lammas or that which is called the spring-wheat. My opinion was, the lammas, having years ago in two or three

seasons given spring-wheat a fair trial, and always found it of much less value than lammas. My recommendation then was to sow the velvet-red or any other good brown wheat; which being so sown produced good crops. A few years ago I tried the experiment of sowing wheat in eight succeeding months, from September to April, and found that the best wheat was produced from that sown in the beginning of February; but I do not mean from this experiment to recommend sowing at such time, excepting under particular circumstances.

Hand-hoeing is a tedious operation. Drilling is now so correctly done, that crops may be horse-hoed without being injured. Many wheat crops after clover do not need much hoeing, only wanting perhaps a few thistles spudded up: if so, it is better not to loosen the land by hoeing, for wheat likes firmness round its roots; and, if on a light soil, nothing should be done likely to let in drought. I find the wheel-hoe I invented, to be pulled forward by a little boy and guided by a youth, a cheap and expeditious way of hoeing drilled corn, and a great assistant in hoeing turnips drilled on a flat surface.

Cutting wheat should begin before the crop is quite ripe, otherwise those who have much wheat to reap must let some of it remain uncut too long, and thus lose, by its shedding in the field, much of the finest grain. It ripens differently in different seasons; sometimes it dies at the root first; when it does, it should be cut, although the straw should appear to be too green. Wheat reaped early in the morning, with a strong dew, should not be bound up in sheaves till the dew is entirely dried out. It is a good plan to have the shocks of sheaves thrown down a little time before they are pitched into the waggon, that the butts of them may dry if damp; and that mice, which may have crept into the sheaves, may escape from them, instead of being carried to the barn or house.

It has often been said that growing wheat is not injured by a field of fox-hunters riding over it; and even produces more grain in consequence. On light soils it does not do the injury that might be expected from appearance; but on strong land it does great harm, for in all the holes formed by the horses' feet, and particularly if going down hill, water will stand, and the plants in those holes will die. But immediately after sowing, the trampling of horses does good. A late friend of mine in the Blues, who occupied a farm of light soil near Windsor, found it to be a great benefit to his wheat crops to have his troop walked up and down them, not galloped, immediately after sowing.

XXII.—*Observations on the Natural History and Economy of various Insects affecting the Turnip Crops, including the White Cabbage-Butterflies, the Turnip-seed Weevil, &c.* By JOHN CURTIS, F.L.S., Corresponding Member of the Imperial and Royal Georgofili Society of Florence, &c.

PAPER IV.

CABBAGE AND TURNIP BUTTERFLIES.

ALTHOUGH some caterpillars will feed upon a great variety of plants, for the most part they are confined to a few, and those are generally of the same natural order, that is to say, they are kindred species. This is the case with the Cabbage-Butterflies,* whose caterpillars not only frequently completely destroy that useful vegetable in the cottager's garden, but they live to a great and often to a mischievous extent upon turnips, rape, &c., as will be shown in the sequel. There are three species of these Butterflies, belonging to the ORDER LEPIDOPTERA, and to a FAMILY called PAPILIONIDÆ, which embraces all butterflies, amounting in Britain to about eighty species,† forming the Linnæan Genus *Papilio*; but the White Cabbage-Butterflies and two or three others have been separated by modern naturalists, and are now distinguished as the GENUS *PONTIA*.‡ The largest of these is abundant in gardens, turnip-fields, and road-sides, where it is seen on the wing from the middle of May to October: common as it is, and familiar as every child is with the White Cabbage-Butterfly, how few persons comparatively are acquainted with its origin and transformations! Its history will therefore prove interesting and instructive; but before we proceed to its economy, it will be necessary to describe it, in order to distinguish it from the two others alluded to. From the mischief the Caterpillars occasion to the cabbages it is called

1. *P. Brassicæ*, *Linn.*, or the White Cabbage-Butterfly. The *male* (fig. 1) is white above, the head and thorax are clothed with soft yellowish hairs; the two horns are spotted with black, and the club is black above and ochraceous beneath; the upper wings have black tips in the form of a crescent; the inferior wings have a blackish spot on the upper edge; the body is black; the wings expand $2\frac{1}{2}$ inches; the *female* is larger, being about 3 inches across, and is distinguished by two large black spots on the upper wings, and a freckled splash upon the inferior margin;

* *P. rapæ* departs from this rule; for it has been found feeding upon garden-flowers which are not cruciferous, and even upon the weeping-willow.

† Curtis's Guide, Genera 763-780.

‡ Curtis's Brit. Ent., fol. and pl. 48.

the under sides are alike in both sexes, the upper wings being white, with the tips yellow, and two large black spots near the centre; the under wings are likewise palish yellow, freckled with black; the head (fig. 2) is furnished with two hairy feelers in front, called palpi, the tips being pointed (*a*), and between them is concealed a long spiral tongue or proboscis (*b*).

The female deposits her eggs on various cruciferous plants, especially cabbages, turnips, mustard, rape, radishes, horse-radish, and water-cresses: they are laid on the under side of the leaves, in clusters of twenty or thirty (fig. 3), and are somewhat of the shape of a sugar-loaf, bright yellow, and curiously furrowed and reticulated, as shown in the magnified fig. 4. There is a constant succession of broods during the summer and autumn; one which attracted my notice hatched the 27th of August, and the little caterpillars immediately consumed all the egg-shells: on the following day they were like fig. 5, green before and yellow behind; a little hairy, with the head, two spots on the first thoracic segment, another on the tail, and numerous little dots, black: they kept together, feeding upon the turnip-leaf in groups, and in one night a single family ate a large hole completely through; they had 6 pectoral, 8 abdominal, and 2 anal feet, and possessed the power of spinning a fine slight web over the surface, probably to enable them to hold more securely to their food: in six days they changed their skins, after which they dispersed over the leaves; in about the same space of time they cast their skins a second time, when they were at least half an inch long, leaving their exuviae sticking to the stalks (fig. 6). When full grown they attain the length of about an inch and a half, and are as thick as a small goose-quill; they are then pale blue or green above, yellow beneath, with a line of the same colour down the back, edged with black dots; there is likewise a row of large black spots down each side, and numerous minute dots as well as fine hairs scattered over the body (fig. 7). Having arrived at this stage, they generally wander to some secure place, under ledges of paling, coping of walls, branches of trees, hedges, &c., and there attach their tails to some object, by very tough silken threads, and afterwards spin a similar cord from their mouths, which is fastened round the animal to support its head in an elevated position (fig. 8 *c*), and, gradually contracting its body, the skin is slipped off, and it is instantly changed to a shining pale green chrysalis, spotted and dotted with black (fig. 8), and in this tranquil state the latter broods rest suspended, uninjured by the storms and frosts of winter, until the genial warmth of spring calls the sleeping inmate into active life, and, as this proceeds, the black spots of the wings, although in miniature, gradually become more distinct through the horny transparent shell, and eventually

the butterfly bursts the back of the chrysalis, crawls out, and, holding by some object so that the little wings hang down, the fluids descend into them, they rapidly expand, and in the course of half an hour have attained their full size; they are, however, still flaccid, and require some time to dry and become adapted to flight.

The caterpillars of the White Cabbage-Butterfly greatly injured some Swedish turnips the end of last September, and no doubt frequently assist in reducing the foliage very considerably; but it is when the turnips, &c., are in seed that they are most to be feared. In July of the same year I received some of the caterpillars from Mr. C. Parsons, of Southchurch, Essex, who informed me that they were then committing extensive ravages on the white-mustard crops in parts of that neighbourhood, by eating off all the pods, and leaving the stalks bare, as shown in the stem, fig. 9. They commenced at the point of the pod, and continued eating until it was demolished, even to the base of the foot-stalk. "Had they attacked the crop," says Mr. Parsons, "at an earlier period of the season, the consequences would have been very serious indeed. Mustard-seed, both white and brown (*Sinapis alba* and *nigra*), is subject to the attacks of a small black larva, which I have not seen this year; but the damage done by the caterpillars I have sent has never been noticed in this neighbourhood."

I placed some of these larvæ upon radishes and turnips in seed, the green pods of which they were equally fond of, and ate, as above stated. They grew most rapidly during the few hot dry days we had near the middle of September, 1841, resting lengthways upon the naked stalks, after having cleared off all the seed vessels (fig. 7): on the 20th they appeared healthy, but inclining rather to a yellow colour: it rained during the night, and, on looking at them in the afternoon of the following day, I saw they had removed to a leaf, to which they stuck by four of their hinder legs, and to my surprise they were of a dirty colour, and rotten, the skins being lax, and lying just as the wind blew them about. I found they only contained some cream-coloured fluid, a portion of which was scattered upon the leaves. From this fact it may be inferred that wet is sometimes very destructive to them, probably during hot weather only; for after the heavy rains which fell the end of September and in October, I was astonished to see the cabbages in the cottage-gardens in Suffolk with multitudes of these caterpillars half and full grown, which had injured the crops so extensively, that not a leaf had escaped. It is scarcely credible that the labouring classes should thus suffer their crops to be spoiled, and their labour to be lost, when a little hand-picking every evening would soon relieve their gardens from these unwelcome visitors; but so it is.

If it were not for numerous parasitical insects, which deposit their eggs in these caterpillars, all chance of keeping them under in the field would be fruitless: the most serviceable of these agents is a little fly, which must be produced in myriads, for I have sometimes found that every caterpillar had been stung by this insect, which belongs to the ORDER HYMENOPTERA of the FAMILY ICHNEUMONIDES ADSCITI, and is named

2. *Microgaster glomeratus*, Linn.* It is black and thickly punctured: the horns are thread-like, longer than the body in the male, shorter in the female, and composed of 18 joints or upwards: the eyes are lateral, with three little eyes or ocelli upon the crown: the abdomen is shorter than the thorax, depressed, linear, smooth and shining; the basal segment is a little narrowed, with the edges on the sides dirty white: ovipositor concealed beneath the abdomen: the four wings are very transparent, iridescent, with a distinct pitchy-coloured stigma on the superior; the nervures lighter, the areolet open externally: legs bright ochreous, hinder thighs black on the upper edge, darkest at the apex, tips of their shanks and tarsi brownish, the apex only of the four anterior brown: length a little more than one line; expanse three (fig. 10).

This minute Ichneumon-fly lays numerous eggs in the caterpillars of the White Cabbage-Butterfly, which hatch and feed within their skins in almost incredible numbers, the victim feeding and growing until it has attained its full size, when, instead of changing into a chrysalis, like fig. 8, a number of fleshy maggots (fig. 11) come through its skin, and form beautiful little oval silken cocoons in masses beneath and around it, like the balls of the silkworm in miniature (fig. 12); they are bright yellow; and I counted sixty-seven which issued from one unfortunate larva. On opening a caterpillar thus infested, it will be found full of little fat maggots (fig. 11), which eventually consume all the muscles, leaving only the alimentary canal untouched: those in my possession, which spun up in September, hatched the beginning of the following May, when they were ready to commence their invaluable operations upon the early broods of the White Cabbage-Butterflies. Reaumur says the *Microgaster* pierces the skin of the caterpillar with its short oviduct, and deposits an egg; it then withdraws it, and repeats the operation, until thirty eggs or more are introduced into the living caterpillar, and they are inserted sufficiently deep not to be cast off with the skin: the maggots avoid feeding on the vital parts, so that the caterpillar does not die until two or three days after the parasites have eaten their way out to spin their cocoons, but the caterpillar, being exhausted, gene-

* Curtis's Brit. Ent., fol. and pl. 321; Guide, Genus 554, No. 54.

rally dies close to his murderers. Even these parasites are subject to the attacks of a beautiful little fly, called *Diplolepis* (*Pteromalus*?) *Microgastri* of Bouché,* the maggots of which live in the pupæ of *Microgaster glomeratus*, three or four together, and the silken cases which are inhabited by these parasites are paler than the healthy ones: thus one little animal lives upon another; so that the laughable lines of the facetious poet are partly verified:

“ That fleas have little fleas to bite ’em,
And so go on *ad infinitum*.”

Persons who are ignorant of the wonderful operations of nature, often mistake these yellow cocoons formed by the maggots for the eggs of the caterpillars, and accordingly destroy them, although they ought rather to be preserved; and others, on opening a caterpillar of the White Cabbage-Butterfly and finding it full of little maggots, have supposed they were the young of it. Such errors are the offspring of ignorance, and contrary to the laws which regulate the generation of these animals; and I trust that these careful investigations will meet with the attention of agriculturists, that they may take a correct view of these subjects, which are at once interesting and of absolute importance to mankind.

There is also a large Ichneumon-fly, the larva of which lives singly in the chrysalis of *P. Brassicæ*, and changes into a white pupa inside, without forming any case: the fly hatches in two or three weeks; it is likewise HYMENOPTEROUS, and of the FAMILY ICHNEUMONIDÆ: it has been named

3. *Pimpla instigator*, *Fab.*; † it is black and thickly punctured; the two slender horns are not so long as the body, and composed of numerous oblong joints; the elliptical abdomen is only slightly narrowed at the base; the thighs, shanks, and feet are bright fulvous, excepting the hinder feet, which are brown or black; the four wings are dull-yellowish, but iridescent, the stigma and nervures brown, the areolet is rhomboidal; the female has a stout ovipositor projecting beyond the apex, and is nearly half as long as the abdomen: the male is often $\frac{1}{2}$ an inch long, the wings expanding more than $\frac{3}{4}$ of an inch, and the female is considerably larger. This powerful insect likewise infests the caterpillars of many moths, and emits a most offensive scent when touched: I have frequently seen the females running over fruit-trees, investigating every leaf and crevice to find a proper object to receive their eggs: they are met with from Midsummer to Michaelmas.

There are other parasites which destroy the chrysalides; and one of the most essential of these is a minute brilliant fly, which deposits its eggs upon the outside of the chrysalis of the Butterfly,

* Naturgeschichte der Insecten, p. 168.

† Curtis's Brit. Ent., fol. and pl. 214; and Guide, Gen. 515, No. 103.

as soon as the caterpillar has cast off its skin, when it is both soft, tender, and exhausted, so that it has not the power to exert itself and frighten away the little parasites: the eggs soon hatch and eat into the pupa, which at that early stage is almost liquid inside, the members of the future butterfly not being organised. Sometimes 200 or 300 of these little maggots live in one chrysalis; they undergo their metamorphoses securely within the shell, and the flies hatch and eat their way out in about fourteen days in summer, but some remain through the winter, and when they come forth they do not fly away, but hover in swarms about the perforated pupa, the males probably hatching first and waiting until the females emerge to be impregnated; but after their bridal dance, each female departs in search of recently formed chrysalides to deposit fresh broods in. If we take 250 as the average number of eggs which a female lays, and admit that one-half of them are of that sex, the second generation would amount to upwards of 30,000, an enormous increase, which is in all probability multiplied several times in the course of one season. Some species of this extensive genus swarm even in our houses, especially in the country, where in October and November I have seen immense numbers inside of the windows, and I believe they hybernate behind the shutters, in the curtains, &c. The species above alluded to is likewise HYMENOPTEROUS, and of the FAMILY CYNIPIDÆ, or CHALCIDIDÆ; it may be the *Ichneumon puparum* of Linnæus, but as that is very doubtful I have named it

4. *Pteromalus Brassicæ*.* *Female* dull blackish-green, thickly punctured; head large, antennæ clavate, black, basal joint ochraceous; abdomen oval, depressed and pointed, black, shining, bright-green at the base, with a violet tint beyond it; wings transparent, iridescent, with an ochraceous nervure along the upper or costal margin of the superior, forming a short branch beyond the middle; legs bright ochre, coxæ black, thighs, excepting the base and tips, pitchy, apex of feet black; length 1 line, expanse nearly 3 (fig. 13).

The first broods of this little parasite hatch in April, and I have bred multitudes of them from a chrysalis of *Pontia Brassicæ*. I suspect the following insect will prove to be the male of it, different as it is in appearance, having bred several from the pupa of one of the White Cabbage-Butterflies many years since, when I gave it the name of

5. *Pteromalus Ponticæ*. *Male* brilliant green, thickly punctured, head brown, horns ochraceous, filiform; abdomen linear, concave, apex ovate, very shining, often with a golden tinge; 4 wings,

* Guide, Gen. 627 and 641; and vide Brit. Ent., fol. and pl. 166, *Colax dispar*.

as in *P. Brassicæ*; legs, excepting the coxæ, bright ochraceous, tips of feet pitchy; length rather more than 1 line, expanse $2\frac{1}{2}$ lines.

We now come to the 2nd species of White Butterfly injurious to turnips; it likewise feeds upon cabbages, mignonette, nasturtiums, &c.; it makes its appearance with the White Cabbage-Butterfly, which it very much resembles, but is smaller; the eggs vary, and the caterpillar and pupa are quite different: from its feeding on the turnip it is called in England the "Small White" or "Turnip Butterfly," and for the same reason Linnæus named it

6. *Pontia Rapæ* (fig. 14): the *male* is white, the superior wings have black tips dusted with white, and the inferior wings have a black spot on the upper edge: the *female* is similar, but has two large black spots likewise beyond the centre of the superior wings; underside of the same white, the apex yellow, and two black spots beyond the middle, the lower one sometimes nearly obliterated; inferior wings yellow, freckled with black: length of male 8 lines, expanse about 2 inches; the female is larger and sometimes of a duller colour; but I possess a male, taken near Oldham in Lancashire, which has all the wings of a bright yellow colour.

The female lays her eggs *singly* on the under sides of the leaves, and they are not very unlike those of *P. Brassicæ* in form and sculpture, but the caterpillars are totally different, being green and so densely clothed with minute hairs as to be velvety; they have a yellowish stripe down the back and another along each side, the belly being of a paler brighter green; they are often more than an inch long, and about as thick as a large crow-quill (fig. 15): they change to a chrysalis, suspended in like manner to fig. 8, but it is of a pale flesh-brown, freckled with black (fig. 16).

The 3rd species is the "Rape-seed," or "Green-veined White Butterfly," to which Linnæus, from its feeding upon the cole-seed, gave the appellation of

7. *Pontia Napi* (fig. 17): the *male* is white, head, thorax, and body black, clothed with yellowish down; superior wings with the tips powdery black and the nervures greyish; inferior wings with a black spot on the upper margin, and the dark nervures shining through. *Female* with the nervures in the superior wings darker, the apex blacker, and two large black spots beyond the middle: under side of superior wings with the same two black spots; the apex is yellow and the nervures are dark, forming grey stripes: the inferior wings are pale-yellow, with the nervures still more distinct, from the broad grey margin which surrounds them. In some examples the nervures are much less strongly marked, which may be a difference between the spring and autumnal broods, or

it may arise from their crossing with *P. Rapæ*, for hybrids undoubtedly exist amongst insects. The males are nearly $\frac{3}{4}$ of an inch long, and scarcely expand 2 inches; the females are a little larger.

The eggs of this species are also laid singly on the under side of the leaves of cabbages, turnips, and other Cruciferæ; they are long, cylindric, of the form of a sugar-loaf, channelled, striated transversely, and whitish (fig. 18): the caterpillars are about the size of the foregoing; they are of a delicate green colour, densely clothed with velvety hairs, the spiracles or breathing pores down the sides being reddish-yellow (fig. 19); and when lying stretched out on the leaves, as they do by day, they are scarcely visible to the eye. The chrysalis is suspended like the others; it is of a pale greenish-white, or yellow and freckled, with the beak and points brown (fig. 20).

There are two broods of this Butterfly in a year, one in April or May and another in July or August; the caterpillars are most injurious in gardens, where last year they not only fed upon the turnip-leaves, but did great mischief to the cabbages, especially in September, eating the central leaves, like the caterpillar of the Cabbage-Moth, *Noctua Brassicæ*, and I killed several as late as the 22nd of September. I have found the pupæ of this species with a largish hole on one side, from which had issued a parasitic Ichneumon; and I bred an incredible number, considering their size, of males and females of this fly in July or August from one pupa; it is called by Gravenhorst *

8. *Hemiteles melanarius*:† the male is entirely black and punctured; the abdomen is roughly punctured, the margins of the segments and the apex are smooth and shining, the two slender horns are scarcely so long as the animal: the wings are beautifully iridescent, the nervures and stigma pitchy, the areolet is open outside; legs black; the apex of four anterior thighs and their tibiæ are tawny, the feet are brownish, but the basal half of the hinder tibiæ alone is tawny: length 2 lines, expanse near 4 lines: the female differs so materially that no one would suppose it was the legitimate partner of the foregoing male: it is black, but the abdomen is red, excepting the basal segment and the apex; the ovipositor is exerted, and is half the length of the abdomen: the thighs and shanks are red, the apex of the hinder tibiæ and all the tarsi are brown: length, including the ovipositor, nearly $3\frac{1}{2}$ lines, expanse almost 5 lines.

Where any of the White Butterfly caterpillars abound, there are several methods of reducing their numbers and checking their increase; the best is to look in the winter for the chrysalides,

* Ichneumonologia Europæa, vol. ii. p. 790, No. 233.

† Curtis's Guide, Gen. 503, No. 233.

which are concealed under ledges of walls, paling, doors, window-sills, on bushes in hedges, on the trunks of trees, &c., and crush them, but on no account to destroy the dark-brown coloured ones, which are full of the parasitic *Pteromali*: as the spring advances, examine the leaves and bruise the clusters of eggs of the largest species, which are as conspicuous as a mass of fly-blows; at the same time a ring or bag-net may be used to catch the butterflies; and when the caterpillars are large enough to be seen, hand-picking is neither difficult nor laborious: when they attack the seed-crops, shaking the stems might prove useful, provided troops of ducks were to follow and pick up the caterpillars; or dusting the plants with hellebore-powder, fresh and genuine, would be worth a trial, as it is very effective in some instances.* After what has been stated, it is almost needless to say that the little yellow cocoons observed upon the plants and leaves, and often surrounding the caterpillars, ought never to be destroyed, as they contain a parasite which proves the cultivator's greatest friend and the most active scourge of the Turnip and Cabbage Caterpillars.

Even the obnoxious and persecuted wasp assists in the destruction of other insects, upon which it preys, making some amends for robbing our orchards. When at the end of summer the sweet thistle-flowers attract a variety of butterflies and swarms of insects, the wasps are busily employed in capturing them, which they do very skilfully. I have many times seen them carry off large flies from the ivy-flowers, and even the White Butterflies are not too large to deter the wasps from attacking them: the species called *P. Rapæ* it seems is most subject to their assaults, and their mode of securing this Butterfly is very curious as related by Mr. Newport in the 'Entomological Transactions.'

On breaking off some of the turnip-leaves close to the crown last October, I found enclosed in the stem (fig. 21) two caterpillars nearly $\frac{1}{2}$ an inch long, of a whitish colour, with a nut-brown head (fig. 22); they were evidently the larvæ of some small moth, but they both died.

CHRYSOMELA BETULÆ?

I also discovered in July, on the backs of some turnip-leaves, many small oval eggs (fig. 23), so deeply imbedded in the pulpy substance, that in many instances the cuticle had burst on the upper side, so that the eggs, which were of a bright ochraceous colour, were perfectly visible; the surrounding margins of the leaf were dried and of a dark-brown colour. There were mul-

* Mr. Lymburn cleared a few hundreds of gooseberry-bushes from caterpillars, at the expense of 1s. 3d. for hellebore-powder, and a morning's work of two men.—*Gardeners' Chron.*, Jan. 1st, 1842, p. 7.

titudes of larvæ with them, which had emerged from the eggs, and were eating holes in the leaves. (fig. 24.) These larvæ can crawl about, having six pectoral feet and a proleg at the tail, the intermediate segments being very much produced, like nipples on the sides; they are of a smoky yellow colour, spotted with black; the head is black, with short antennæ and four small feelers; the 1st thoracic segment is dull, the 2nd and 3rd have four small black spots on the disc, and the following only two, but larger (fig. 25); they are slightly hairy, and there is a line of brown tubercles on each side close to the spiracles, from which the animal can protrude yellow shining glands, when it is excited or put to pain: these larvæ are of course very small at first, and never attain a large size, yet they eat innumerable holes in the leaves. I placed several upon a turnip-leaf, and believe they entered the earth to become pupæ, for they soon disappeared. There is no doubt that they change to a beetle of the Genus *Chrysomela*, which belongs to the same Family as the "Turnip-fly Beetle" (*Altica Nemorum*);* but it cannot leap, and it is far from improbable that these larvæ are the offspring of

9. *Chrysomela* (Phædon) *Betulæ*, Linn.: † a brilliant shining blue or green oval beetle, with the under side, horns, and legs black, and about $1\frac{1}{2}$ line long, which I have often found upon turnip-leaves.

CURCULIO ASSIMILIS, the Turnip-seed Weevil.

I shall for the present notice only two other insects, both of which are injurious to the turnips when in flower and seed: the economy and habits of one were only discovered last summer by a friend, who sent me some turnip-seed in a pill-box the end of June, containing also twenty or thirty maggots: on scattering the contents of the box upon a sheet of paper, the maggots stretched themselves straight out and walked very well. I was at the same time informed that a small bag of fresh rubbed-out "nimble-nine-weeks" turnip-seed was strewed in a paper tray and placed before the fire for the purpose of being well dried, when numbers of these little maggots were seen crawling amongst the seeds. On examining the seeds, however, I could not find any holes in them; I therefore placed the maggots in a pot of earth, and they soon buried themselves. About a week after this my correspondent examined some of the remaining pods of the turnip, and found one with a small hole in it (fig. 28): on splitting it open it was evident that the seeds had been eaten, and it appeared that the hole had been made by a maggot in order to effect its exit: three pods

* Royal Agr. Soc. Jour., vol. ii. pl. A, figs. 4 and 5.

† Curtis's Guide, Gen. 433, No. 5.

were also forwarded to me, each being punctured, and on opening them I found only one seed untouched, and two that were but slightly eroded; others were half consumed, and many entirely eaten up—a hard gummy substance of a dark colour enclosing the spot occupied by the maggots, which might be the dung compressed by the animal: but to connect these circumstances satisfactorily with the maggots, it is necessary to state that one of them was found in a pod: the maggots are fat and yellowish white, the body is formed of numerous convex muscles, the head is pale brown (figs. 26 and 27): they buried themselves 2 or 3 inches beneath the surface, and enclosed themselves in brown oval cocoons (fig. 29), which were very brittle, and formed of the agglutinated grains of earth, and in one I found the pupa (fig. 30); it was of a dull ochraceous tint, the eyes black, and on being magnified, the rostrum, legs, and wing-cases were very distinct (fig. 31). After remaining three weeks in this inanimate state the beetles began to hatch, and by the 21st of July nearly twenty specimens were liberated: they proved to be a small Weevil which is abundant during the summer in the flowers of the turnip, cabbage, and other cruciferous plants, the wild-mignonette (*Reseda lutea*?), &c., and no doubt deposits its eggs at that time in the embryo pods. It belongs to the ORDER COLEOPTERA, of the FAMILY CURCULIONIDÆ, or Weevils, and is called, by entomologists of the present day,

10. *Ceutorhynchus assimilis*, *Payk*,* the Turnip-seed Weevil; it is also known as the *Curculio obstrictus* of Marsham. It is black, clothed with short white depressed hairs above and scales beneath, which give the insect a grey tinge; rostrum long, slender, and arched, smooth and naked towards the apex, furnished with two geniculated or kneed horns, placed on each side a little beyond the middle, composed of twelve joints, the basal joint long, the seven following short and nearly globose, excepting the second and third, the terminal ones forming an ovate-conic club, hoary at the apex; eyes placed on each side at the base of the rostrum; thorax triangular, the anterior part being the narrowest and truncated, the margin reflexed, thickly and coarsely punctured, with a tubercle on each side somewhat towards the base; there is an impression down the middle terminating in a fovea behind, with a short channel in the breast to receive the rostrum in repose; elytra short and ovate, with about eight fine channels on each, the interstices punctured; wings ample; legs rather short; thighs thickish, narrowed suddenly towards the apex, the hinder have a single short tooth beneath; shanks straightish, the apex rounded and pectinated; feet four-jointed, two basal joints some-

* *Curtis's Guide*, Gen. 345, No. 43.

what triangular, third bilobed, fourth slender and clavate, furnished with two claws: $1\frac{3}{4}$ line long, including the rostrum (fig. 32).

In the 'Introduction to Entomology' it is stated by one of the learned authors of that interesting and invaluable work that a small Weevil has been bred by him from the knobs or galls on the roots of the Kedlock (*Sinapis arvensis*).^{*} This little Beetle is similar in form and nearly related to the foregoing insect, but it is infinitely smaller, and has been named by Marsham

10*. *Curculio* (*Ceutorhynchus*) *contractus*. It is black with a coppery tinge; the head and thorax are coarsely punctured; the elytra are generally green, sometimes inclining to blue, rarely blackish; they have punctured striæ down each, with lines of minute hairs between them, and the apex is tuberculated: length from $\frac{3}{4}$ to 1 line.

This little Weevil in the perfect or beetle state destroys the young turnips by puncturing the leaves, as I am informed by Dr. J. W. Calvert, who thus confirms the statement in the 'Introduction to Entomology,'[†] where it is said that almost as much damage is sometimes occasioned by this little Weevil as by the Turnip-fly (*Altica Nemorum*); and Dr. Fleming, of Flisk, also bears testimony to the injury this *Curculio* does to the turnip-crops.

As all these weevils are so sensitive that they fall down, if only approached suddenly, from the flowers or leaves on which they are feeding, they may be easily collected, when they abound in the turnip-flowers left for seed, by shaking the stalks over a bag-net or cloth; but as they immediately unfold their legs and begin to run away after the shock is over, the contents thus collected must be swept into a pail of lime and water or urine until they can be removed and destroyed by pouring boiling water over them, for, as their horny jackets are very hard, they are not easily killed by stamping upon them.

CETONIA AURATA, the Green Rose-chaffer.

Another large and beautiful beetle, whose larvæ are exceedingly injurious in gardens and nurseries,[‡] sometimes does great mischief the beginning of May to the turnips then in flower and intended for seed by destroying the anthers, by which means the flowers prove abortive; and as these beetles often breed amongst strawberry-beds, and first attack their flowers, it is not safe to have turnips to be reserved for seed cultivated in a garden or in the vicinity of one where that fruit is grown, for the beetles fly well, especially

* Vide Kirby and Spence, vol. i. p. 450.

† Ibid., vol. i. p. 185.

‡ Gardeners' Chronicle for 1841, p. 452.

in the sunshine, and after consuming the flowers in one spot they can readily fly to another for the same purpose. This handsome beetle naturally belongs to the ORDER COLEOPTERA and the FAMILY MELOLONTHIDÆ, and is called *Scarabæus* by Linnæus, but it now bears the designation of

11. *Cetonia aurata*, or the Green Rose-chafer : it is of a brilliant metallic green, often having a golden or copper hue; the head is oblong, notched in front, and thickly punctured; the eyes are prominent; the horns short and ten-jointed, terminated by an oval club formed of three plates; the thorax is large, punctured, somewhat triangular or semi-ovate, the sides rounded, the base indented; the sides of the trunk have a spine on each side, which is very visible even when viewed from above; the scutellum is large and elongate-trigonal; the elytra are oblong, the shoulders project, with a scale on each side of their base, and hollowed out where the spines are; they are punctured; the suture is keeled, especially towards the apex, which is truncated, and leaves the extremity of the abdomen exposed; there are various spots upon the elytra more or less of a pure white or ochraceous colour, forming transverse but irregular streaks towards the hinder part, as if the surface was cracked: the wings are very long, rusty yellow, with horny ferruginous nervures, and are folded beneath the elytra, excepting in flight; the under side is coppery, inclining to rose-colour; the face, thorax, and breast are clothed with soft ochraceous down, the latter with a metallic knob projecting between the base of the two intermediate thighs; the legs are strong, anterior the shortest; the shanks are ciliated with ochraceous hairs on the inside, the anterior are notched externally, forming three teeth, the others have a tooth outside, about the middle; they are all furnished with a pair of spines at the apex called spurs, excepting the anterior, which have only one; the feet are rather long, slender, and slightly compressed, composed of five joints, the terminal one being the longest, and producing a pair of strong claws:* length from 8 lines to more than $\frac{3}{4}$ of an inch (fig. 33).

These beetles not only attack the flowers of the strawberries and turnips, but they may be found nestling among the petals and stamina of the white-thorns, mountain ash, elder, roses, lilac, candytuft, peony, &c. The female, like the cockchafer (*Melolontha vulgaris*),† deposits her eggs in the ground, where they hatch and produce little maggots, which live two or three years underground, feeding upon the roots of grass and various plants until they are full grown, when they are as thick as a swan's quill and an inch and a half long, fat and whitish, with an ochraceous

* Curtis's Brit. Ent., pl. and fol. 374.

† Ibid., fol. 406.

head ; short, horny, and strong jaws ; six short pectoral feet, all of a rusty ochraceous colour : the body is composed of numerous rings of muscles, clothed with transverse series of ferruginous hairs, which enable the animal to progress more readily upon its back ; the hinder portion is the thickest, curved, and of a lead colour, and is sparingly covered with rusty hairs ; on each side of the first thoracic segment is a horny rusty spot, which readily distinguishes it from the grub of the "Great Cockchafer," which is also hairless, with feet of a different shape. When they have arrived at their full growth they form an oval case of earth at a considerable depth as large as a walnut, which is covered outside with the excrement of the animal, formed of oval pellets of the soil, and resembling the dung of mice. It is very remarkable that the larvæ of the Green Rose-chaffer often live in ant-hills, without being annoyed or attacked by those hostile little animals, whence in some countries they are called "King of the Ants ;" and it is also said, but it is scarcely credible, that many German cattle-dealers attribute to these grubs supernatural powers, that they feed them in boxes, believing that as they thrive, so will their cattle increase and their fortunes prosper !* It is to be hoped this was the superstition of bygone days, and that the light which has dawned upon Europe during the happy years of peace, when the Arts and Sciences have been cherished and cultivated, has enlightened the minds and exposed the follies of the darker ages, when war and rapine engrossed the energies and debased the understandings of all classes.

When the sun shines and the Green Rose-chafers are flying about, they may easily be caught with a bag-net ; but early in the morning, before they are revived by the rays of the sun, or in the evening, when they repose in the flowers, it is easy to pick off these large and conspicuous beetles ; they may be collected into cans or bottles of water, and afterwards taken away and thrown into boiling water to deprive them of life.

Having often alluded to a ring or bag-net for catching insects, it may be useful to give instructions for making this instrument, which may be easily done by getting three or four feet of wire, not less than a quarter of an inch thick ; bend the wire into a ring at least one foot across ; the ends must then be soldered into a ferrule, or made to screw or slip into one with a catch to hold it fast, at the pleasure of the maker. The ferrule must be firmly fixed at the end of a staff or stout walking-stick 2 or 3 feet long ; and a bag from 1½ to 2 feet long, made of canvass, such as ladies use for worsted-working, or that employed in cheese-presses, or any coarse gauze that will allow the air to pass through, must be

* Curtis's Brit. Ent., fol. 374.

sewed or fastened round the iron ring; or if a sheath of leather be first fixed round the ring, the bag may be attached to it, which will make it last longer, and it can be more readily replaced when it is worn out by sweeping herbage or other rough work. With such a net any insects may be readily caught with a little practice. The net described is adapted to brush bushes and sweep along the ground, &c.; but if one be required for catching butterflies by day, or moths in the evening, the ring must be lighter, the stick may be made of a cane or bamboo, and the bag should be of silk-gauze or bobbinet.

Summary of the foregoing Report.

There are *three species* of White Butterflies which injure the Turnip and Cabbage crops.

The first is called the "*White Cabbage-butterfly*," which deposits its eggs in clusters on the under side of Cabbage, Turnip, Mustard, Rape, Radish, Horseradish, and Watercress leaves.

When first hatched the *caterpillars* live in *society*; but when a week old they disperse.

They remain through the *winter* in the *Chrysalis* state, suspended in secure retreats in walls, paling, &c.

The *caterpillars* greatly injured some *Swedish turnips* last September.

They do still greater mischief by eating off all the *pods*, in crops of *Turnips* and *Mustard* left for seed.

The full-grown *caterpillars* died suddenly of some disease after a wet night, during very hot weather.

Cabbages in cottage-gardens might be readily freed from this pest by *hand-picking*.

A Parasitic fly, called *Microgaster glomeratus*, lives in and destroys great numbers of the caterpillars.

The *little yellow silken cases* found round the dead caterpillars should never be destroyed, as they contain these useful parasites, whose operations are certain and invaluable.

Ignorant persons destroy them, believing them to be the eggs of the caterpillars; but caterpillars never lay eggs.

The *Microgaster* has also a smaller parasite which lives upon it, called *Diplolepis Microgastri*.

A large Ichneumon, called *Pimpla instigator*, also lives in the caterpillars of the White Cabbage-butterfly.

Pteromalus Brassicæ and *P. Ponticæ*, two other minute flies, lay their eggs upon the *Chrysalis*, and materially assist in keeping these butterflies in check.

The second species, "*The small White*" or "*Turnip butterfly*," lays her eggs not in clusters, but singly, on the under side of the leaves of Cabbages, Turnips, Mignonette, Nasturtiums, &c.

The third species is the "*Rape-seed*" or "*Green-veined White-butterfly*," which also lays its eggs singly on Cabbages, Turnips, &c.

These caterpillars eat into the central leaves of the Cabbages, and did great mischief last year.

Of all these Butterflies, there are *two broods annually*, one in spring, the other in summer.

A little Ichneumon, called *Hemiteles melanarius*, infests and destroys the Chrysalides.

To get rid of the Cabbage-caterpillars, look for and *destroy* the *chrysalides* in winter; in the spring *crush* the clusters of *eggs*, *hand-pick* the *caterpillars*, and catch the butterflies in the garden.

In *seed crops* shake the stems, and let in troops of *Ducks* to pick up the caterpillars as they fall down.

Hellebore-powder recommended to destroy them.

Wasps destroy many insects, and amongst others the *White Cabbage-butterflies*.

The caterpillar of a *small moth* lives in the footstalks of the Turnip-leaves.

The leaves are often eaten by the small black larva of a beetle, *Chrysomela Betulæ*?

A small maggot lives in the *Pods* of the Turnip, eating the seeds; when full fed it eats its way out of the pod, and changes in the earth to a pupa, from which comes the Weevil called *Curculio assimilis*, which inhabits the flowers of the Turnip, Cabbage, &c.

Another Weevil, the *Curculio contractus*, punctures the Turnip-leaves to a great extent.

These small beetles may be collected by shaking the flowers over a cloth or bag-net.

The *Green Rose-chaffer* seriously injures Turnip-flowers, by devouring the anthers, and rendering the germen abortive.

The eggs are laid in the ground, where they become maggots, and live three years in that state.

The conspicuous *Green Rose-chaffer* should be collected by *hand-picking*, and killed with boiling water.

Instructions for making a *Bag-net* to catch insects.

EXPLANATION OF THE PLATES.

Fig. 1. The White Cabbage-butterfly at rest.

Fig. 2.*The head in profile.

a. The two palpi or feelers.

b. The spiral tongue or proboscis.

Fig. 3. A cluster of the eggs on the under side of a leaf.

- Fig. 4.* A single egg magnified.
- Fig. 5. The young Caterpillar when first hatched.
- Fig. 6. Their skins cast off, and sticking to the stalk.
- Fig. 7. A full-grown Caterpillar.
- Fig. 8. The Chrysalis suspended to the stalk.
c. A silken thread, which sustains it with the head uppermost.
- Fig. 9. A branch of the White-mustard (*Sinapis alba*), showing how the pods have been entirely eaten off to the stem below, and the ends of the seed-vessels consumed above.
- Fig. 10.* A parasitic fly, called *Microgaster glomeratus*, which destroys the Caterpillars of the Cabbage-butterflies.
d. The natural size.
- Fig. 11.* One of the Maggots taken out of the body of a Caterpillar.
e. The natural size.
- Fig. 12. A cluster of yellow silken balls, called Cocoons, which have issued from the body of the caterpillar, and each of them will produce a fly like fig. 10.
- Fig. 13.* Another parasitic fly, called *Pteromalus Brassicæ*, which destroys the Chrysalides of the Cabbage-butterflies.
f. The natural size.
- Fig. 14. "The small White Turnip-butterfly" at rest.
- Fig. 15. The Caterpillar of the same.
- Fig. 16. The Chrysalis fixed by its tail and a thread to the stem.
- Fig. 17. The "Rape-seed" or "Green-veined White-butterfly," represented standing.
- Fig. 18.* The egg magnified.
† Two of the eggs of the natural size, laid singly on the under side of a leaf.
- Fig. 19. The Caterpillar of the same.
- Fig. 20. The Chrysalis suspended like the others.
- Fig. 21. A Turnip-leaf broken off to show a cavity in which a caterpillar was living.
- Fig. 22. The Caterpillar alluded to.
- Fig. 23. The eggs of a Beetle laid on the under side of a Turnip-leaf.
- Fig. 24. One of the larvæ feeding, which hatched from the eggs.
- Fig. 25.* The same larva magnified.
g. The natural size when full grown.
- Fig. 26. A Maggot which lives in the pods of the Turnip, and consumes the perfect seeds.
- Fig. 27.* The same magnified.
- Fig. 28. The aperture eaten by the maggot to get out when it has arrived at maturity.
- Fig. 29. The little case which it forms in the earth.
- Fig. 30. The Chrysalis taken out of the case or cocoon.
- Fig. 31.* The same magnified, showing the limbs, &c., of the future Beetle.
- Fig. 32. The Turnip-seed Weevil, called *Curculio assimilis*, which is the parent of the above maggot.
h. The natural size.
- Fig. 33. "The Green Rose-chafer," *Cetonia aurata*.

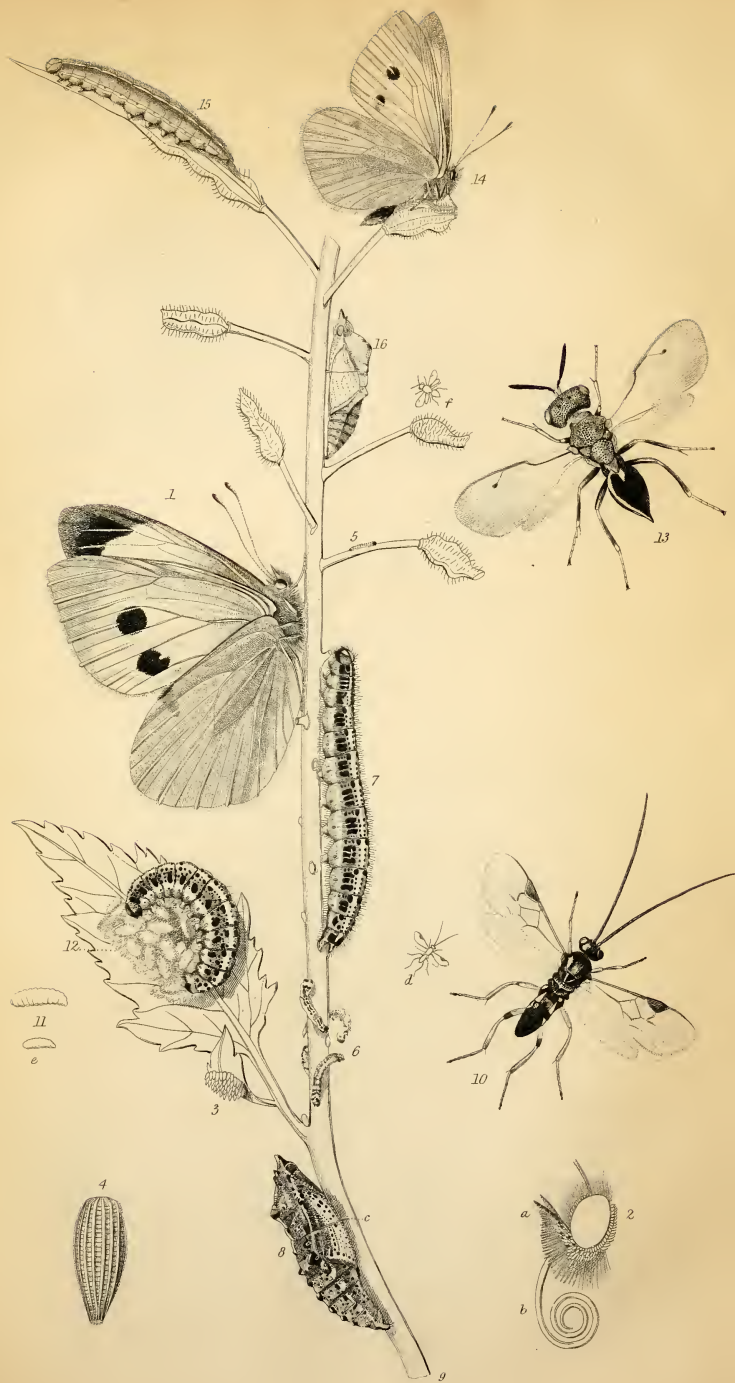




Fig. 34. The crown of a small Turnip, with all the leaves cut off excepting one.

Fig. 35. A small portion of the stem of a Turnip, with two of the seed pods remaining.

Obs.—All the figures are drawn from nature, excepting 15, 19, and 20; and the numbers with a * attached, indicate that the objects referred to are represented much larger than life.

London, August, 1842.

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XXIII.—*On the Use of Burnt Clay as a Manure for Heavy Clay Soils.* By FRANCIS PYM.

To Ph. Pusey, Esq.

MY DEAR SIR,—I now send you, as you wished, a report of my experience in the use of burnt clay, which I have applied to land more or less for the last seventeen years.

For the first ten years it was upon a heavy clay-land farm in Cambridgeshire, about two miles south of Caxton, on the old north road, and for the last seven years on the heavy land I occupy here, which is of better quality than the Cambridgeshire farm; but both on a strong clay subsoil, and requiring under-draining.

In both cases I have burnt all the borders, headlands, and grass-balks in the fields, which had been enclosed with straight quick fences about thirty years ago, but had yet been cultivated as in the open field system, with high-backed lands, ploughed in a serpentine direction, leaving in every field a great deal of waste land as above described. This has not only furnished excellent materials for burning, but also a supply of turf for draining, which, cut in the wedge form, is one of the cheapest and best modes of performing that necessary operation, without which the profitable occupation of heavy land cannot be carried on.

The work of burning is begun in May, and continued through the summer, in heaps, containing from 50 yards to 100 yards each, at an expense of 6*d.* or 7*d.* a-yard, which includes everything except a few roots and brush-fagots, the quantity of which varies according to the supply of turf. The average value of the wood consumed is about 10*s.* for every hundred yards of ashes. The great art is to let the clay burn slowly, which depends very much upon the proper formation of the walls, which are of turf, as the ashes then turn out black for the most part, and are considered much better than when they are red and clinking like bricks. The more turf and vegetable matter the better (as weeds,

scouring of ditches, and rubbish of every kind); but if sufficient turf can be raised to form the walls of the clamps, we find that with the assistance of a few more roots or fagots a great deal of clay with very little of any vegetable matter can be reduced to ashes. The fires require watching at night as well as in the day-time, that they may not go out; and the clay always burns best that has been dug a week or two before clamping.

I have invariably found the application of burnt earth attended with beneficial effects, though I have not made any experiments by which to ascertain the exact amount of advantage. When ashes have been used, the land works much more freely for several years, is sooner dry, and the produce is considerably increased. Upon both farms I have succeeded in raising the average produce of wheat nearly 10 bushels per acre, and other crops in proportion. The average used to vary from 15 bushels to 25 bushels per acre, now from 25 bushels to 35 bushels; and I have found burnt clay one of the most useful auxiliaries in producing this satisfactory result.

I have also found ashes very useful upon heavy grass-land, greatly improving the quality of the herbage, and enabling me to keep more stock. Upon one field in particular, which had been badly laid down, the quality of the herbage has been so much improved by the application of burnt earth, that I have determined to let it remain in grass, instead of breaking it up, as I before intended.

The quantity used on strong arable land varies from 40 yards to 50 yards per acre; on woodland arable, 30 yards is sufficient; on grass-land from 20 yards to 25 yards. For grass-land I sometimes mix the ashes with unburnt earth, lime, and a small quantity of yard-manure, to form compost heaps.

The ashes are generally carted on in a dry time, as soon as convenient after harvest, and put upon clover-leys, bean or tare stubbles, or fallows, either for wheat, barley, or oats, as the case may be, and I have occasionally used them upon young seeds. I consider the effect lasts seven or eight years, when, if a supply can be provided, they may very safely be repeated.

Very truly yours,

F. PYM.

The Hazells, Baldock.

Having been allowed by Mr. Pym to inspect his heaps of burnt clay at the Hazells, I found that many of them contained so much lime as to deserve the name of marl. There was one heap of mere clay; but, as it was burnt in a fresh situation, it did not appear quite clearly that this clay had ever been successfully applied to

land. This practice, which was recommended by General Beatson, and of which Mr. Pym has given so satisfactory an account, still continues in many districts on a limited scale. I have obtained the following account of it from a correspondent in another county:—

“Having been requested to communicate with you on the subject of clay-burning, I am happy to do it as far as my knowledge of it extends. My attention was first called to it, above twenty years ago, at a Bedfordshire Agricultural Meeting, where the subject was discussed; and I heard it declared by some farmers then present that they could not cultivate to any profit their strongest and worst lands but by the help of clay-burning. And a friend of mine, afterwards on the Buckinghamshire side of that county, confirmed the same statement. Consequently, being obliged to take into my own hands an impoverished strong-land farm here in Leicestershire, I resorted to the same expedient; and, encouraged by me, some of my neighbours did the same, and we all found the benefit of it.

“By *clay-burning* we do not of course mean *paring* and *burning*, in which there can be little or no clay, and of which the ashes are expected to operate as a manure by reason of the decomposed vegetable alkali in them; but we mean, taking the inert mass dug at any depth below the first 7 inches from the surface, such as the contents of newly-made pits, the bottoms of ditches made deeper than before, and the outcast of soughs. In this there can be very little of a feeding or fertilizing quality, though I cannot but think that a red or blue clay is of more value than a dirty white. And I have no doubt that stiff chalks or clayey stonebrash, after the action of fire, would be much of the same quality. The most waxy clay-lands, well dressed over with well-burnt clay, not only become lighter and milder, as by the action of lime, for the time, but so they continue for several years. A neighbouring farmer tells me that a field he dressed in this way 7 years ago has ploughed easier by a horse-draught, and *has been like different land* ever since, whereas lime, especially if very caustic, when once saturated with rain, makes the land closer and colder than ever. Strong land, on which barley is never a full, and always a hazardous crop, fallowed and dressed over with burnt clay, and seeded down with barley in the spring, never fails to give a very good crop, and to be well covered with the clover for the next year. In *clay-burning*, however, there is great skill and judgment and management required. Indeed I know of no part of husbandry that does require so much good sense joined with experience in the burning. And upon this all depends. If it be well done, it is a great benefit to the farmer; if ill, it is quite the reverse. A nobleman in this neighbourhood made a large pond in the solid clay, and burnt all the outcast: there must have been between 2000 and 3000 loads; and he top-dressed the worst part of his parks with the ashes, falsely so called. And in three years afterwards they were above half carried off again, in the substance, though not in the shape, of brick-ends, to make foundation for roads.

“The heat should always be slow and steady, never, if possible, burning

the clay red, but black; though this is very difficult indeed to manage, depending very much on the wind; and it is best effected by making heaps of not less than 60 or 100 loads in each; and these will take from two to three months to burn. All inexperienced hands use too much fuel, get their fires too fierce, lay their stuff too hollow, make a great deal of smoke,—whereas the less they make the better,—get their heaps to a red heat, and burn them through in a week or ten days; and the consequence is, that, when those heaps are opened, instead of ashes, or lumps that will fall by exposure into ashes, out roll knobs as hard and as useless as brick-ends. Much also depends on the size of the clay-lumps, and their state of humidity; if too dry they will burn too fierce, and if too wet they will not burn at all. And again, there is a great deal in the management of the fire, which we make of refuse coals from the pits, at about 3s. for a waggon-load. You, I expect, would use fagot-wood, and that might simplify the process.

“If you have a quantity of clay-land, and fuel cheap, I have no doubt you would find the benefit of the clay-burning system; but, have it well done, or do not make the attempt. As general observations, nothing more occurs to me than to add that these ashes should be laid on thick, chiefly on fallows, and at the rate of 40 cart-loads, or nearly, to the acre.”

Specimens of the earth used in this case are some of them marl and some clay. Altogether, it does not appear quite clearly that clay without lime can be used for this purpose; particularly as it is more apt to burn into hard lumps than marl. But our cold clay-lands are so much in want of any substance which would open them, that the process appears to deserve a trial on a small scale, even where they are not found to contain any lime.—PH. PUSEY.

XXIV.—*On the Failure of the Red Clover.* By the Rev. W. THORP.

A SEVERE loss frequently occurring to agriculturists is the destruction of the red and white clover crop, the cultivation of which is of so much importance that every exertion should be made to secure a full crop; for upon its success depends the number of sheep to be sustained during the summer, the quantity of fodder for horses in the winter, and the ensuing corn-crop is materially influenced by the weight of the produce consumed on the land. There is, however, in this climate no plant more difficult of culture in the early periods of its growth, or which so frequently fails in its progress towards maturity, or of which by repetition the land is said to be so soon tired. Upon the magnesian limestone nearly one-half of the red clover sown fails (200 acres out of 450); upon the chalk wolds of Yorkshire, owing to frequent failures, many

farmers have given over sowing red clover, while the white clover is very often only half a crop; and upon the oolites and other light soils of the new red sandstone and of the coal district, red clover, owing to frequent losses of the crop, is only sown once every twelve years. An inquiry, therefore, into the general and extensive causes of the failure of this plant, and consequent loss to the farmer, cannot but be of advantage.

In a paper read before the Yorkshire Agricultural Society last year the causes of failure, *at the time of sowing and during the summer months*, have already been pointed out, and it is concerning the failure of the clover-crop *after harvest* to which the following remarks will be more particularly directed. In this case the crop after harvest is always good, but dies away during the months of October, November, December, January, February, and March, the lands on which this occurs being denominated "clover sick" from a supposition of the too frequent repetition of that crop.

The committee of the Yorkshire Agricultural Society in the report of last year directly ascribe the failure to *the exhaustion of some food required by the clover*. They say, "Mr. Thorp has collected a great mass of evidence to prove that on certain soils clover may be grown at short intervals. The committee, on the other hand, have shown that certain other soils will not grow it with advantage oftener than once in twelve years. These apparently contradictory facts may be reconciled on the supposition of *the food of clover being exhausted*." Mr. Legard in the same report says—"On the much controverted question of clover-sickness, my opinion is, that the soil is rendered unfit to produce successive crops of this plant, *either by excretions* given out by the roots, or *by the exhaustion of certain constituents* of the soil by the plant itself."*

In order, if possible, to ascertain whether the opinion of the food being exhausted were correct or not, two samples of soil were sent for analysis to Mr. Spence of York, a very acute chemist, recommended by Professor Phillips. The samples were taken from the same field about 10 yards apart, being upon the lower bed of the magnesian limestone. This field is 16 acres, one half of which had been seeds (that is white clover and ryegrass) and the other half beans four years ago, the whole of which last year was barley and red clover; and both portions of the field had previously been under the same management with respect to crops and manures. After harvest the whole clover was equally good; but during the months from November to the 5th of April the clover had, I may say, totally disappeared from the portion which had four years before been "seeds," except upon

* Report of the Yorkshire Agricultural Society, 1841, p. 136.

the headlands where the horses had turned round in the ploughing. Upon the portion which had been beans four years ago the red clover continued excellent until it was mown; but the other half was not worth keeping, and was ploughed up and sown with beans.

SOIL OF THE BAD CLOVER.

Mechanical Analysis.

Deposit in $3\frac{1}{2}$ minutes	90
Remainder	10
	<hr/> 100 <hr/>

Chemical Analysis.

Water of absorption	4.5
Water not expelled at 300° , and matter destructible by heat . .	} 3.5
Sulp. lime	} 0.15
Chloride sodium	
Vegetable matter (soluble) . .	0.10
Siliceous and insoluble in hydro- chloric and sulp. acids	} 80.5
Alumina	4.6
Oxide iron	4.65
Carb. lime	1.25
Carb. magnesia	0.25
Phosp. lime (phos. acid .067) .	0.15
Silicate of potash (potash .17)	0.35
	<hr/> 100. <hr/>

SOIL OF THE GOOD CLOVER.

Chemical Analysis.

Deposit in $3\frac{1}{2}$ minutes	90 $\frac{1}{2}$
Remainder	9 $\frac{1}{2}$
	<hr/> 100 <hr/>
Water of absorption	4.5
Water not expelled at 300° , and and matter destructible by heat	} 3.5
Sulp. lime	} 0.10 —, 5
Chloride sodium	
Vegetable matter (soluble) . .	0.10
Siliceous sand insoluble in hydrochloric and sulp. acids	} 79.50 —, 55
Alumina	4.8 —, 2
Oxide iron	5.3 —, 35
Carb. lime	1.15 —, 1
Carb. magnesia	0.45 +, 2
Phosp. lime (phos. acid .09)	0.2 +, 05
Silicate of potash (potash .2)	0.4 +, 05
	<hr/> 100. <hr/>

An acre of 1 ton of red clover contains of potash, 45 lbs.; soda, 12 lbs.; lime, 63 lbs.; magnesia, 7.5 lbs.; alumina, 0.3 lbs.; silica, 8 lbs.; sulphuric acid, 10 lbs.; phosphoric acid, 15 lbs.; chlorine, 8 lbs.—(Lectures on Agricultural Chemistry, by J. F. W. Johnston, p. 326.)

The analyses of both soils are here given, and the comparison shows the soil of the bad clover to be actually richer in gypsum and common salt than the soil of the good clover; it, however, contains a little less magnesia, phosphate of lime, and of silicate of potash.

But by comparing the number of pounds weight of inorganic substances required per acre, with any of the ingredients in which the bad soil is deficient, it will be found that there existed in the bad soil an ample quantity of each of them. Take the quantity of phosphate of lime, the only one about which there can be a doubt, the quantity in the analysis being 0.15 per cent., and therefore of phosphoric acid .067 per cent.; but a crop of red clover requires only of phosphoric acid 15 lbs. weight per acre; and an acre of this soil 6 inches deep weighed on the 5th of April 2766.060 lbs., and therefore contained 180 lbs. weight of

phosphoric acid—so that, if the analysis had contained only .001 per cent., it would have contained 27 lbs. ; nay, if it had contained .0005, it would have contained $13\frac{1}{2}$ lbs., which is nearly sufficient, not only of phosphoric acid for the red clover, but which would also be a sufficient quantity of chlorine, sulphuric acid, magnesia, and soda, for either a crop of barley, rye-grass, or wheat. This shows that even the analyses of soils given by Professor Liebig are not sufficiently minute, although they exhibit the thousandth part per cent. of the substance analysed; yet, before it can be asserted that any soil is deficient in alumina, soda, sulphuric acid, or magnesia, chemists must, owing to the small quantity of matter required in so large a mass, give us less than one-half of the decimal parts afforded in those given by Professor Liebig. In fact, before it could have been predicated whether the clover on this soil had failed for the want of alumina, it must have been ascertained whether the soil even contained .000011 per cent. of that earth.

But in addition to the positive evidence afforded by the comparison of the two analyses of the soils that there is no exhaustion of the food of the clover, we have the high authority of Professor Liebig, who says, “In some neighbourhoods clover will not thrive till the sixth year, in others not till the twelfth; flax in the second or third year. All this depends on the chemical nature of the soil; for it has been found by experience that, in those districts where the intervals at which the same plants can be cultivated with advantage are very long, *the time cannot be shortened even by the use of the most powerful manures*. The destruction of the peculiar excrements of one crop must have taken place before a new crop can be produced.”—Chemistry applied to Agriculture, p. 157.

Indeed, Mr. Legard himself almost proves that its failure cannot on the chalk wolds be ascribed to the want of any ingredient of the clover, when he says “that for a period of eighteen years he has used bones to the turnip-crops at the rate of 2 quarters per acre, to the clovers rich farm-yard dung 10 tons per acre, and to the wheat-crops rape-dust at the rate of 12 bushels per acre, and that the clover-crops have been consumed on the ground by sheep.” Surely, if land be manured in this way, no exhaustion of the soil can take place: and upon the magnesian limestone it is scarcely possible that exhaustion of any specific ingredient can be the cause of failure, because it is the custom to sow beans upon these “clover-sick” lands, wherever the soil is not very shallow; and, if a good crop of beans can be grown on the same lands, it follows that certain fixed ingredients must have been present in the soil; for beans contain as much potash, soda, magnesia, alumina, and silica, as red clover, but a little less gypsum, phosphoric

acid, and chlorine, but not an absence of the three last, otherwise they would not grow at all. In fine, this single consideration alone, that the clover flourishes luxuriantly during the warm and growing months of the summer, when food of all kinds is required and assimilated by the plant, but perishes in the colder months, when vegetation is nearly dormant and scarcely any nourishment required, must preclude the opinion that the want of food of any description whatever is concerned in its destruction.

Will an excretion, or rather the emission of excrementitious matter, from the roots of clover, account for its disappearance? for in this opinion Professor Liebig coincides with that of Mr. Legard. But against such an agent being concerned, it may be urged in the first place that there are certain light lands which have been reclaimed only thirty years ago, and therefore never have produced clover at any former period, but upon which the crop always disappears in the winter. A farm near Barnsdale Bar upon the magnesian limestone, several farms on the south side of Darrington upon the same geological formation, and certain portions of the Yorkshire Wolds, are in this predicament. No excrementitious matter therefore can destroy the clovers on these farms, because they have never grown the plant. Macaire Princep found that the leguminosæ (to which family the clovers belong) emitted gum and carbonate of lime. But the gums are very soluble in water, and therefore would be easily washed out of the soil; and it seems very extraordinary that in the heavier soils, consisting of loam and clay of the new red sandstone, this *gum trifolii* should only remain three years, while in the lighter soils of the magnesian limestone eight years, but in the still more open and porous soils of the chalk wolds it endures twelve years. In fact, this wonderful substance, contrary to the known law of *eremacausis*, decomposes more slowly in proportion to the porosity of the soil, and in those containing the most calcareous matter. Again, if this excretion can remain in the soil nearly twelve years, it must be decomposed very slowly, and therefore afforded to the plants in a very weak solution; but Saussure found that *plants do not suffer much by weak solutions of poisonous matters*. Again, it seems very singular that the poison is only absorbed in the winter months when vegetation is languid, and that the clover from this cause should not perish during the warm months and the period of its greatest growth. But the red and white clovers are perennials; Smith, in his 'English Botany,' describes them both as such. The red clover (*Trifolium pratense*) grows as a perennial in the Vale of Aylesbury and in the rich pastures of Lincolnshire, and Mr. Baines, the editor of the 'Flora of Yorkshire,' says that it grows as a perennial near York: now, if this plant excretes in one year as

much as will poison the soil upon which it grows for ten or twelve years, how is the same plant enabled to live continually in the midst of its own accumulated excretions? In fine, the conclusions of Macaire's experiments have been disproved by Meyen and Unger. They obtained excretions from those plants only whose roots had been mutilated by their removal from the soil into water, which is not their natural medium of growth; but in employing water-plants, and placing them in various solutions, they could not detect by the most delicate re-agents the rejection of any of the absorbed agents. (See 'Root,' Penny Cyclopædia.)

But the following anatomical and pathological examination of the dying red-clover plant will prove that no poison received by the roots is concerned in its death; for plants which are poisoned assume a very different appearance.

During the last winter I took from different fields, and particularly from the clover-sick portion of the before-named field, a great number of dying plants at different periods of the winter, and examined them with the microscope, slices of whose stems and leaves were placed under a magnifying power of 100 to 150 diameters. The part first injured is the neck of the plant (collet), about a quarter of an inch below the point where the leaves join the stem. If slices of the neck be placed under the microscope in the early stage of the injury, the sap-vessels are found simply ruptured; while, if the plant has been some time affected, as shown by its foliage, a dark spot will be seen in the centre of the stem, and the more external parts of a brown colour; and, as the disease spreads upwards, the stem becomes black in its entire thickness, decomposition takes place, and the plant rots away a little below the base of the leaves. This destruction of the cellular tissue is owing to *the severity of the frost*; and if the common cauliflower or the celery-plant at the same period of the year be examined, the same effects are visible. In the cauliflower, about 3 inches below the leaves, the centre of the stalk is found in its early stage simply softened, afterwards it assumes a brown colour, and emits, if broken, a putrid smell, decomposition having taken place. In the celery-plant, the neck becomes filled with a brown sap, and the blanched leaves soon take on the appearance of frost-bitten celery. The first external symptom of the disease in all the plants is a spotted-yellow and dead appearance of the edges of the leaves, which takes place first in those most developed, while the leaves recently expanding seem healthy, but subsequently the whole plant above the neck becomes of a dark colour, and if pulled breaks off, leaving the lower portion of the roots healthy in appearance.

There is no doubt that the disease is immediately caused by

the sap of the plant becoming frozen, and the air which is contained in it expelled among the sap-vessels; the heat of the sun then expanding, the confined air, before re-absorption of it by the frozen sap can take place, bursts the vessels of the plant. This is proved by the fact that any frosted plant may be preserved if it be gradually thawed by either pouring cold water upon it, or by protecting it from the sun's rays. Several hundred plants of red clover from different localities were examined during the winter, and the same effects were always visible.

A number of plants were taken up and placed in a stove in their native soil, having a temperature of 60° to 65°. Of those taken up in November about one-half continued to live, while of those taken up in January all died; some of the latter had their soil changed, but they also died away in about ten days. Some of those plants which were taken up early in the season, survived, because their sap-vessels were not irremediably damaged, while in those taken up later, the vessels were destroyed to an extent incompatible with the life of the plant.

It being proved that the clover crops are destroyed in this country by the frost, the next inquiry is, why are they injured on particular soils, or sometimes on a soil where this crop has been successively grown, as every third, or every fourth year? Upon certain soils of the new red sandstone at Fishlake and Fenwick, red clover has been grown every third year for a series of years, (this is shown in the 'Yorkshire Agricultural Report,' p. 125,) while upon portions of the chalk wolds of Yorkshire neither red clover nor white clover can now be scarcely cultivated at all, and it may be safely asserted that it is only upon the more pulverulent soils of the magnesian limestone, of the chalk, and of the sandstones of the coal-measures, and some of the lighter soils of the new red sandstone and oolite, that this crop is injured by the frost, or that become "clover sick." If it is destroyed on a stiff soil, it is from an excess of water, and because it is too wet; the natural home of red clover being a dry compact loam, firm and close on the surface.

The true answer to this inquiry is, that the remote cause of injury by the frost, is owing to the want of a certain degree of cohesiveness of the particles of the soil among themselves, and hence the soil's power of retaining heat is diminished; and those plants, particularly clovers, which are impatient of sudden change of temperature, are readily destroyed by the frost.* And soils, by the

* "The power of retaining heat is nearly in proportion to the weight of a determinate volume of soil, *i.e.* to absolute weight; the greater mass an earth possesses in the same volume, the greater will be in general its power of retaining heat. We may, therefore, from the absolute weight of an earth, conclude, with a tolerable degree of probability, as to its greater or less

growth of white clover, red clover, and tares, become more pulverulent, puffy, and less cohesive, in proportion to the frequency of the growth of these crops; and this explains why these lands tire of clover. The several particles of earth, by the long, deep, and numerous radicles of these plants, become mechanically forced from their position, and their points of contact thus rendered fewer in number; and such soils comparatively become specifically lighter in proportion to the weight of a determinate volume.

That the soils upon which the clover is destroyed do lose the cohesiveness of their particles, and, when compared with those of the same chemical constitution which preserve the plant, are specifically lighter in proportion to the weight of a determined volume, is proved by the following trials, in which a solid foot of each was dug from the ground and weighed upon the spot.

In the two portions of the field whose soil was analysed, several trials of the weight of the two soils gave a difference of 6 to $7\frac{1}{4}$ lbs. per solid foot, (of $17 \times 17 \times 6$ inches, or 6 inches in depth,) or from 117 to 140 tons weight per acre over and above the failing or sick portion of the field; and this difference of the weight does not arise from a difference in the specific gravity of the two soils (indeed the lighter contains more silica), but from the particles of earth not being in equally close contact.

In another field, belonging to Mr. W. Stephenson of Womersley, upon the new red sandstone, which is rather peaty, and possesses a subsoil of clay, one portion of it was swede turnips, which were pulled off; another, potatoes; a third, white turnips, which were eaten off the ground with sheep; a fourth portion, open fallow, manured with rape-dust. All these different pieces were sown with barley and red clover; but the red clover disappeared in the winter from all except one, viz. the white turnips eaten off with sheep, and which weighed—

11 $\frac{1}{4}$ lbs.	per foot of 6 inches deep	(or 216 tons per acre)	more than the swedes.
5 $\frac{1}{8}$ lbs.	„ „	(or about 100 tons)	more than the potatoes.
10 $\frac{3}{4}$ lbs.	„ „	(or about 200 tons)	more than open fallow.

The treading of the sheep in eating off upon this soil added a

power of retaining heat.” (Schubler on the Physical Properties of Soil, Journal of Eng. Agric. Soc., vol. i. part ii. p. 177.) “When different earths are mixed together, a cubic inch of the mixture obtained gives a greater weight than the arithmetical mean (or common average) of the earths entering into the mixture, whether mixed in equal portions according to weight or volume, or in other quantities.” (Ibid., p. 181.) *e.g.* 2 parts of sand, and 1 part of clay, by volume, have an arithmetical mean weight of 2566, while the actual weight is 2825, or an increase of 259.

weight of $11\frac{1}{4}$ lbs. per solid foot, and the additional density and compactness in the soil of this particular piece evidently enabled the red clover upon it to endure the severity of the winter.

In a field in the occupation of Mr. Ruddock, of Wentbridge, upon the magnesian limestone, which was an open summer fallow, but in the spring was sown with barley and red clover, the latter died away in the winter from all parts of the field except upon those headlands where the horses had turned round in ploughing. These headlands where the clover was good gave an excess of $5\frac{3}{4}$ lbs. per foot in weight (or 100 tons per acre) over the soil which had no clover upon it, but which was covered with weeds.

In a field belonging to Mr. Rowley, of Kirk Smeaton, situated upon the "red marl and gypsum," between the two beds of magnesian limestone, one portion was oats and very inferior white clover; the other portion was barley and very good white clover. The soil of the good clover, which was firm and dry, gave $6\frac{1}{4}$ lbs. per foot (of $17 \times 17 \times 6$), or about 120 tons in weight per acre, above the inferior portion. One half of the inferior clover was manured with gypsum thrown from a deep drain, but the frost equally destroyed the plants upon it.

In several trials of the soils of fields, where circular patches only of the clover had disappeared during the winter months, the result was invariably the same, viz. a lighter weight of the soil, and that averaging from 6 lbs. to 9 lbs. per solid foot of 6 inches deep and 17 inches square.

In another field, belonging to Mr. Stones, of Kirk Smeaton, which was examined without knowing under what circumstances the clover had failed, two trials gave only a difference per solid foot of $\frac{1}{2}$ lb. between the portion which had good red clover upon it and that which had no clover. In this case, however, Mr. S. assured me that there was no clover after harvest to be seen, and that it had been destroyed by the barley crop being excessively luxuriant, and which was "lodged."

The theory here offered of the failure or destruction of clover after harvest, viz. *that it is always killed by the frost, and this in proportion to the want of a certain degree of cohesiveness of the particles of the soil*, will alone explain all the contradictory opinions that have been offered respecting the causes of its failure.

1. It explains why some lands, as those situated upon the chalk, oolite, and magnesian limestone, mentioned in the 'Report of the Yorkshire Agricultural Society,' after being "*tired*" are by rest able to reproduce this crop; because, the more frequently the clovers, or tares, or any large tough-root plant are sown, the less compact and lighter in weight does that soil become; and, at length, there is produced from this cause an incapacity of the

clovers growing upon them to resist the frost; yet in time, by the decomposition of these roots, and the cultivation of bulbous-rooted crops, and the treading of the soil by sheep in eating them off, as is usually practised, reconsolidation of the soil takes place, and the same land is thus enabled again to sustain clover against the severity of the frost.

2. It explains why, in some fields from which the whole clover crop has nearly disappeared, the headlands, where the horses turn round in ploughing, usually preserve the plants untouched by the frost. This is particularly observed on the wolds.

3. It explains why, on the strong tenacious clay-lands around Hemsworth, red clover after teazles invariably fails; while, upon the magnesian limestone, particularly around Kirk Smeaton, red clover after teazles succeeds better than after any other crop:—because, in the one case, the continual treading of the teazle spittalers and reapers makes the strong land too tenacious, while the same treading on the light and porous limestone affords the consistency required to preserve the crop over the winter.

4. It explains why the Duke of Portland found clover to stand the winter on a portion of a field in which the turnips had been manured with farm-yard dung, while, upon the other half, manured with bones, the clover perished:—because the latter have a tendency to keep the land open and to render it specifically lighter, remaining undecomposed several years, and thus the clover upon it to be more affected by frost.

5. It explains why certain portions of the magnesian limestone will produce red clover every fourth year, other portions only every eighth, others every twelfth, while other portions, as at Barnsdale, on the south side of Darrington, &c., will not, with the heaviest manuring, produce that crop at all so as to stand the winter:—because the compactness of the limestone soils is very variable; some require pressing for wheat, others do not; some contain 5 per cent. of alumina, others not 1 per cent.; some 12 per cent. of lime, others not 2 per cent.: hence, upon the more compact, the clover will stand the winter, while upon other portions it will not do so.

6. It explains why, in the south of England, a working flock of sheep is of so much value:—because by their treading they give great solidity to the soil, and also a capacity to the clovers upon it to resist sudden changes of temperature.

7. It explains why claying or marling clover-sick lands, as mentioned by Mr. Morton (*Agricultural Report*, p. 77,) should in Norfolk be a sufficient remedy:—because clay and marl give tenacity to the soil, and the power before mentioned.

8. It explains why lime is called the mother of seeds to certain soils:—because this earth is one half of the value of clay in giving

tenacity to soil. (See Journal of Eng. Agricult. Society, for 1839, Part ii., p. 185.)

9. It explains, for the same reason, why chalking upon the Yorkshire wolds is of so much value to the clover crops. Indeed, by walking over these lands, it may at once be told whether the land has received this operation by the firm sensation conveyed through the feet.

10. Lastly, it explains the failure of the numerous trials of the growth of the *Trifolium incarnatum* (the scarlet clover), which would be an invaluable plant, but invariably dies in winter if sown upon land recently ploughed, which it is usually sown upon; while, if the stubble-land before sowing be simply scratched by light harrows, and after sowing compressed with a heavy roller, it will stand the winter.

Sprengel remarks that the clovers delight in a close-topped soil, or one which admits no great quantity of oxygen to the roots. The best clover grown in Great Britain is upon the warp soil in marsh-land near the river Humber; for not only is such a soil dry and compact, but abounds in microscopic animalculæ. Ehrenberg has discovered that the mud of the various harbours in Europe contains from one-third to half of its volume of distinguishable organic bodies, chiefly polythalamia, from the nitrogen of which no doubt these soils derive their general fertility.

The cause of the failure of red and white clover after harvest being ascertained, the remedy is easily prescribed, for farmers have many ways of imparting compactness to the soil,—viz. by rolling and pressing the surface, by claying, chalking, and liming with caustic lime. I should say, lime the clover-ley when broken up for wheat; press the wheat, and also press the soil for barley; and after harvest, before November,* roll the barley with a heavy roller; and the probability is that we should hear no more of clover-sick lands: at all events, the remote and proximate causes of the disease being discovered, I leave the remedy to the farmer.

Womersley Vicarage, near Pontefract,
Nov. 2, 1842.

* This year (1842) the frosts in the dry weather in October have very much destroyed red clover upon the magnesian limestone. In this part of the country the frosts were very severe at night, followed by a bright sunshine in the mornings; and the effects, p. 421, were witnessed.

XXV.—*On Measuring Cattle.* By C. HILLYARD, of Thorpe-lands, near Northampton.

To Philip Pusey, Esq.

DEAR SIR,—As you think information on that useful practice of measuring cattle to compute the weight of carcase would be acceptable for insertion in the Royal Agricultural Society of England's Journal, I have the pleasure of sending the following relative to the subject.

About five-and-thirty years ago I met with tables for the measurement of cattle, the weights computed in stones of 14 lbs. As stones of 8 lbs., or scores per quarter, were the only weights thought of in Northamptonshire, I reduced the stones of 14 lbs. into those of 8 lbs., explaining how readily such stones corresponded with scores per quarter. In 1814 I printed my tables in a small book, which I circulated amongst my friends. The late Dr. Wollaston saw this book, formed his own calculations, and made for Lord Spencer a sliding rule, showing the weights in stones of 14 and 8 lbs. In the third edition of my book '*On Practical Farming and Grazing*' I introduced my tables, giving the weights in stones of 8 and 14 lbs., leaving out those calculations made for such large girths and great lengths of cattle that did not exist.

The measurer should be a sufficient judge of beasts to know whether they are marketably fat or not; if not, the measure will over-rate them;—and also something of their proper formation, so as to be capable of forming a just opinion whether they are proportionably heavier or lighter in their fore-quarters than in their hind-quarters; and thus making such necessary allowance in computing the weight from the sliding-rule, or from the tables in the third edition of my book on *Practical Farming and Grazing*. The method of measuring is, to put a string or tape round the beast, just behind the shoulder-blade, and take its circumference in feet and inches; that is called the girth: then with the tape or string measure from the fore part of the shoulder-blade bone, along the side of the back, over the hip to that bone under the tail which plumbs the line with the hind part of the buttock: this is the length. Opposite these figures in the book or scale is the weight of the carcase, in stones of 8 lbs. and of 14 lbs., when separated from the offal. Thus:—girth, 6 ft. 6 in., by 5 ft. 8 in. length, gives 57 stones 2 lbs. of 14 lbs.; 100 stones of 8 lbs.; which is equal to 10 score per quarter: 7 ft. 10 in. by 5 ft. 10 in. gives 85 stones 10 lbs. of 14 lbs.; 150 stones of 8 lbs.; equal to 15 score per quarter. The girth is easily taken; but the length requires great care to take it correctly. The beast should stand

quite straight whilst measured, and the **exact** part of the shoulder-blade should be felt.

It is only by continued practice that any one is enabled to guess the weight of beasts with accuracy: those persons therefore who have only occasionally a few fat cattle to dispose of meet the purchaser (who is in the constant habit of buying and proving his judgment by weighing the carcase when dead) upon very unequal terms; but that great inequality will be much lessened by this aid of measurement.

It is well known that the weight of timber can be ascertained by external measurement, and, in fact, all solid bodies of the same kind vary in weight according to their size; but the shape of an ox's body is so very irregular a figure, and so much of the internal part is hollow, that, although one may safely assume that the bodies of two oxen which are the same in size will be nearly the same in weight, yet none of the ordinary rules of calculating the solid contents of bodies are applicable in this case. The rule, therefore, on which the tables are formed must have been discovered by the result of repeated experiments, and the only proof which can be given that it is a correct rule is, the experience that it has generally been successful in giving the dead weights of the beasts to which it has been applied.

I have the honour to be yours, &c.

C. HILLYARD.

Thorpelands, near Northampton, August 7, 1842.

XXVI.—*Report on the Exhibition of Implements at the Bristol Meeting in 1842.*

It would be a superfluous task for the Judges of Implements to preface their Report to the Council with any panegyric on the advance made, since the last Meeting, in the science and practical perfection of Agricultural Machinery. The increased area required for the display of the implements bore ample testimony to the fact of a large accession of exhibitors; and the unanimous judgment of hundreds of disinterested visitors pronounced the exhibition to excel all its predecessors in the variety, ingenuity, and general perfection of the vast assemblage. These circumstances, so honourable to the mechanical profession, and so encouraging to the founders and supporters of the Society, have rendered the task of the judges one of increased delicacy and difficulty. They have had to discriminate and decide between the qualities of numerous implements of nearly equal merit; in-

ventions for perfecting or economising processes in husbandry hitherto unthought of, or considered to be unattainable by the agricultural mechanic, have demanded their investigation, and the appropriation of premiums; machines in embryo have been offered to their notice as deserving commendation and encouragement; and their duty has required a frank exposition of the performance—whether excellent or defective—of those implements which were submitted by exhibitors to the practical trial, so wisely and beneficially established by the Society as the test of merit, and the title to distinction. The observations annexed to the several classes of implements assigned by the Council as the subjects of reward, together with the notices of the miscellaneous articles, the selection of which for prizes was left to the discretion of the judges, will explain the reasons which induced them to award, or, in some cases, to withhold, the offered premiums. These running commentaries will, perhaps, convey a more correct idea of the present state of agricultural mechanism, in most of its branches, than if a distinct summary of what has been, and of what remains to be accomplished, were attempted.

It has been asked in our Journal “why, but on account of the separate and secluded scene of the farmer’s industry, is the spread of agricultural inventions so slow?” and, “what, but a central connexion of the cultivators of the soil, can diminish the distance and remove the obstruction?”* The truth of both these observations will find strong and abundant confirmation in the following pages. The energies of thousands are now concentrated and exerted for the common purpose of collecting, comparing, and disseminating the scattered experience of agriculturists, as well as of profiting by every known or possible means of increasing the products of the soil; and it must be the fault, no longer the misfortune, of a farmer, if he remains in ignorance of what is known or practised by others.

The judges present the following

AWARD OF PREMIUMS.

1. PLOUGHS.

To the Hon. M. W. B. NUGENT, of Higham Grange, near Hinckley, Leicestershire, for his Subsoil-Pulverizer, 15 sovs.

To JOHN HOWARD, of Bedford, for his Two-wheeled Plough, 5 sovs.

To the EARL of DUCIE, of Woodchester Park, near Stroud, for a Swing Plough constructed by Mr. Richard Clyburn, 5 sovs.

To JOHN STOKES, of Pauntley Court, near Newent, Gloucestershire, for his Two-wheeled Plough with Pulverizing Knives, constructed by Mr. Wm. Mason, of Grafton, Warwickshire, 10 sovs.

* On the Present State of the Science of Agriculture in England, by Ph. Pusey, Esq., M.P., 1839.—*Journal of the Society*, vol. i. part 1., p. 16.

To ROBERT LAW, of Shettleston, near Glasgow, for his Trenching and Subsoil Plough combined, 5 sovs.

2. DRILLS.

To RICHARD HORNSBY, of Spittlegate, near Grantham, for his Drill for general purposes, 30 sovs.

To MESSRS. GARRETT and SON, of Saxmundham, for their Turnip and Manure Ridge-Drill, 20 sovs.

To WILLIAM GROUNSELL, of Louth, for his Lime and Soot Drill, 5 sovs.

To WILLIAM CROSSKILL, of Beverley, for his Lime and Soot Scatterer, 3 sovs.

To THOMAS HUCKVALE, of Over-Norton, Oxfordshire, for his Liquid-Manure Depositor, 3 sovs.

3. HORSE-HOES.

To MESSRS. GARRETT and SON, of Saxmundham, for their Improved Horse-Hoe, 10 sovs.

To ROBERT LAW, of Shettleston, near Glasgow, for his Expanding Horse-Hoe and Harrow attached, 3 sovs.

To RICHARD MERRETT, of Appleadon, near Newent, Gloucestershire, for his Dutch Horse-Hoe and Harrow attached, 2 sovs.

4. CULTIVATING IMPLEMENTS.

To WILLIAM CROSSKILL, of Beverley, for his Patent Grass-Land Cultivator, 5 sovs.

To MESSRS. COTTAM and HALLEN, of London, for their Light Scarifier, or Grubber, 5 sovs.

5. CAKE-CRUSHER.

To MESSRS. GARRETT and SON, of Saxmundham, for their Cake-Crusher, 5 sovs.

6. TURNIP-CUTTERS.

To MESSRS. SANDERS and WILLIAMS, of Bedford, for their Turnip-Cutter, 5 sovs.

To MESSRS. H. and T. PROCTOR, of Bristol, for their Turnip and Chaff-Cutter combined, 3 sovs.

7. CHEESE-PRESSER.

To W. JAS. GINGELL, of Bristol, and Wrington, Somerset, for his Lever Cheese-Presser, 5 sovs.

8. HAYMAKING MACHINE.

To JAS. LOVELL, of Glastonbury, Somerset, for a Haymaking Machine of his own invention, 10 sovs.

9. HORSE-RAKE.

To JOSEPH COOKE GRANT, of Stamford, for his Improved Patent Lever Horse-Drag Rake, 5 sovs.

10. HARROW.

To BENJAMIN WRIGHT, of St. Nicholas, near Cardiff, for an Improved Harrow, the invention of Mr. EVAN W. DAVID, of Radyr Court, 5 sovs.

11. MISCELLANEOUS.

To WILLIAM CROSSKILL, of Beverley, for his Potato-Steamer, 2 sovs.

To S. J. KNIGHT, of Maidstone, for an improved mode of applying the power to Hand-Threshing Machines, the invention of Mr. Joseph Barling, of Maidstone, 5 sovs.

To ALEXANDER DEAN, of Birmingham, for his Patent Portable Corn Grinding and Dressing Mill, 5 sovs.

To EDWARD PLENTY, of Newbury, Berks, for his Portable Iron Horse-machinery for Threshing Machines, &c., 5 sovs.

To MESSRS. COTTAM and HALLEN, of London, for their Dynamometer, or Draught-Gauge, 5 sovs.

To MESSRS. COTTAM and HALLEN, of London, for the Cocoa-Nut-Fibre Netting for Sheep-Folding, manufactured by Messrs. WILDEX and Co., of Holland Street, Blackfriars, London, 3 sovs.

To JAMES RICHMOND, of Salford, Lancashire, for Worth's Patent Roller Chaff Machine, 3 sovs.

To RICHARD STRATTON, of Bristol, for his Cross-Lock Waggon and general exhibition of Carts and Waggons, 10 sovs.

To ROBERT LAW, of Shettleston, near Glasgow, for his Scotch One-Horse Cart with Improved Tipping Catch, 3 sovs.

To MESSRS. CHARLES and THOMAS THATCHER, of Midsomer Norton, near Bath, for their Cart with Self-acting Brakes, 5 sovs.

To MESSRS. RANSOME, of Ipswich, for their application of Portable and Locomotive Steam-Engines to Agricultural purposes, 30 sovs.

To WILLIAM CAMBRIDGE, of Market Lavington, Wilts, for his Portable Steam-Engine, as applied to Agricultural purposes, 15 sovs.

Drills.—The show of drills far surpassed in number, in excellence of workmanship, and in their adaptation to the several purposes for which the system of drill-husbandry is now so extensively applied, all previous exhibitions. The advance made in the execution of drilling machinery, since the establishment of the Society, is an undoubted proof of the stimulus excited by its prizes, and of the wide-spreading advantage derived from the opportunity afforded to constructors of annually comparing their own productions with those of other makers. Drills have already penetrated into districts where, three years since, their purpose, and even the name of the implement, were scarcely known; and excellent machines were produced from workshops which have but very recently essayed their manufacture. It would, indeed, appear that, unless some new principle be struck out, which shall greatly excel the

present system of construction, little remains to be done as regards fulfilling the required objects of this most important class of implements. Seed-corn of every description may be deposited with the greatest precision, in any quantity, and at any desirable distance and depth. The manure-depositing machinery has, heretofore, opposed the greatest difficulties, but these have rapidly yielded to skill and experience; and, now, even damp compost is put into the soil, conjointly with the seed, and with a regularity which leaves little room for further improvement.

To Mr. Hornsby, of Spittlegate, near Grantham, the Society's prize of 30*l.* was again considered to be due for his drill for corn and general purposes. The implement differs chiefly from that exhibited last year in the parts affecting the delivery of manure or of compost. Mr. Hornsby has succeeded in producing a constant agitation of the manure in the box, by communicating to the stirrers a rising and falling motion, as they revolve, and, at the same time, traverse the box from end to end; so that no part of the contents remains in a quiet state, or can become consolidated. In addition, he has fixed the slide, or inner part of the box, on hinges, so that the attendant can contract or expand the aperture through which the manure falls into the delivering-cups, and thereby regulate its discharge and deposition with the greatest exactness. The whole mechanical arrangements and execution of this drill are excellent, durable, and yet so simple that an ordinary labourer is competent to adjust it for every description of work.

To Messrs. Garrett and Son, of Saxmundham, the judges awarded the premium of 20*l.* for a ridge-turnip and manure drill, and have to notice some alterations in its structure which render the implement applicable to a greater variety of soils than the one rewarded at Liverpool. The drilling part of the machine is now supported on two wheels, from which the requisite power is derived, and motion communicated to the apparatus for stirring and delivering the seed and manure. The pressing-rollers are attached to a fore carriage removable at pleasure. An improvement has also been introduced in the manure-box by giving to the stirrers a perpendicular as well as a revolving movement; and the quantity delivered is regulated by raising or lowering a slide, which enlarges or diminishes the space through which it falls. In the latter respects, however, the judges consider Mr. Hornsby's machinery the most effective.

The excellent assortment of machines exhibited by these and other makers bore testimony to the general advancement of mechanical skill, both as regards finish of work and the large comprehension of the purposes to which mechanism may be rendered subservient in agriculture. In design, as well as in the details of execution, a marked improvement was observable.

Several drills of a more economical character, or restricted to special objects, claimed attention. Mr. Groundsell, of Louth, had a prize assigned him for his drill combined with a newly-invented apparatus for spreading soot, lime, or other light substances, on the surface of the land. Much praise is due to Mr. Grounsell for the great attention he has paid to manure-depositing machinery, and with him, it is understood, the stirrers and expanding sides applied to the manure-boxes of drilling-machines originated. With a little more attention to fittings and finish, Mr. Grounsell's machines would possess still greater excellence; but, whilst making this remark, the judges would caution agricultural mechanics against falling into the opposite extreme, as highly-polished work is not only out of place, but objectionable, when applied to parts of machines inevitably exposed to weather and dirt. It enhances the cost, without any compensating advantage.

To Mr. Crosskill, of Beverley, a prize was also awarded for a drill to scatter soot and lime, possessing, like Mr. Groundsell's, ingenious contrivances for guarding these light substances from the effects of wind during their deposition. To the same maker another prize was given for a novel machine of the drill kind, called a grass-land cultivator. Its object is to renovate mossy or hide-bound pastures by cutting out the old sward in a series of parallel grooves, which is effected by strong coulter set at any convenient width asunder, and to a depth suitable to the soil, a drill at the same time depositing fresh seed and compost. The land is afterwards rolled. This implement appeared to be well calculated for these useful purposes, and may be the means of renewing and fertilising old grass lands and parks, without having recourse to the plough to reverse the sod. A liquid manure-cart, by Mr. Crosskill, with pump attached, and contrived either to spread the fluid, or deliver it upon two rows of turnips at any required width, is to be commended as apparently well adapted to its purpose.

The ingenuity of Mr. Huckvale, of Over Norton, has also been exercised in the construction of an implement for depositing or sprinkling liquid manure. It consists of two water-tight cases for carrying the fluid, fitted into the manure-boxes of his turnip-drilling machine. The fluid is conveyed through a pipe into a second reservoir, in which works a wheel with cups. These collect and throw out the liquid in the desired quantity on the turnip ridges. He applies the same machine to pass along the ridges, to sprinkle the young plants with a fluid which he represents as destructive to the fly. A premium of 3*l.* was adjudged to the inventor for his mechanical skill in bringing about these ends, of

which the precise effect and value can, however, only be ascertained by a practical trial, and experience.

To the above-named gentlemen, to Messrs. Carson, Clyburn, Law, Cottam and Hallen, and others, the Society was indebted for the exhibition of well-executed drills for sowing turnip-seed and manure in single and double rows, and adapted to the use of small occupiers. Several exhibitors also produced drills for sowing clover and grass seeds, which bid fair to become useful auxiliaries to the farmer, by giving to that process the certainty and regularity which render the drill system of husbandry so superior to the broadcast. Mr. Hornsby's implement deserves particular mention and commendation, as it appeared to be admirably suited for these purposes. It is furnished with twenty coulter upon separate iron levers, set at 3 inches asunder, and delivers the seed by means of cups, thereby securing to the delicate grass-seeds the uniformity of drill deposition, with the nearest possible approach to broadcast distribution.

A drop-drill or dibbling-machine, on a novel principle, was exhibited by Mr. William Irving, of Lambeth, Surrey, to which the judges had hoped to give particular attention in the field, but time did not permit; and, as the inventor contemplated making still further additions to it, its effect will be ascertained with greater advantage on a future occasion. The same observations apply to a newly-patented dibbling or seed-dropping machine, the invention of Mr. Shaw, of London, and exhibited by Mr. C. C. Waller, of Great Dover Street, Southwark.

The report of implements shown at Liverpool contained a minute description of the machinery projected by the Rev. W. L. Rham for drilling and dibbling. The implement, with some modifications, was again exhibited, and, on this occasion, submitted to trial in the field. The judges regret their inability to pronounce a favourable opinion of its efficiency in its existing state. The ground was, certainly, in a most unpropitious state for the operations of this machine, yet the experiment was sufficient to warrant the conclusion that the resources of the ingenious and persevering inventor will have to be still further taxed, in order to communicate that force and certainty of action to his dibbles, and to his seed and manure apparatus, which are essential to give practical value to implements of this class.

Horse-hoes.—Horse-hoes for general and special purposes were numerous and well-constructed. The excellent implement of Messrs. Garrett and Son, still further improved, was again selected for the Society's premium, as eminently calculated to answer the various ends to which it is applicable, as noted in the last report.

To Mr. Law, of Shettleston, near Glasgow, a prize was also

given for an expanding horse-hoe and harrow, a powerful, cheap, and useful implement.

Mr. Huckvale's single and double revolving hoe for thinning and hoeing turnips on the ridge system of culture was tried in the field, but under the disadvantage of there being no turnips in growth on which to exhibit its powers. Owing to this circumstance, the judges would consider it to be presumption, on their part, to offer an opinion on its practical efficiency. Whether a machine can be made for materially aiding and expediting manual labour in the thinning of turnips, is a question which can only be decided by ocular inspection and experience of its effects. It is very desirable that this implement, which is simple, and requires but little power, should be practically tested by agriculturists.

To Mr. Richard Merrett, of Appledon, near Newent, a prize of 2*l.* was given for a Dutch horse-hoe and harrow attached. Credit is due to Mr. Merrett for introducing into agriculture one of the most efficient horticultural implements. It is particularly applicable to the cleansing of drill-crops, on fen and peat soils, subject to annual weeds, and to work between the rows of carrots, mangold-wurzel, &c., when the land is not very hard and stiff.

Scarifiers, Cultivators, &c.—The extensive collection in the show-yard of that powerful class of machines for cleansing and working the soil, denominated scarifiers, cultivators, &c. &c., passed under the examination and excited the admiration of the judges; but, as there appeared to be no material improvement effected in the construction of the most efficient of these implements since the exhibition of last year, they did not consider themselves justified in assigning the Society's prize to any one of them. A reward was given to Messrs. Cottam and Hallen for a light scarifier, or grubber, as it seemed well adapted to the use of the small farmer. An enormous machine appeared in the collection of these gentlemen, purporting to be a substitute for the plough, and to act as a general cultivator of the surface of the soil—the invention of Lady Vavasour. Upon trial on a favourable soil, both before and after the plough, it was found that, instead of working the soil, and leaving it in a friable, loosened, or dug state, the earth adhered to the spoon-shaped teeth on the barrel, closed the spaces between them, and accumulated until the machine became an immensely heavy roller, consolidating the ground, and completely reversing the intentions of her ladyship. The judges cannot but regret that previous experiment had not spared them the pain of condemning a principle of construction which was so palpably faulty as to render the failure of this costly implement inevitable.

Cake-crushers.—The competitors for the premium offered for cake-crushers were not numerous. It was adjudged to Messrs. Garrett and Son, of Saxmundham, and well merited for their

strong and complete implement, which separates, if wanted, the dust for calves, breaks the cake large for beasts or small for sheep, and powders it for manure.

Corn-cleaning Machines.—Corn-cleaning or dressing machines seemed to have exercised the ingenuity of several well-established makers, and the workmanship bestowed on them may be pronounced to be of an improved order; but no very particular superiority being discernible among these implements, the Society's prize was not awarded. The Earl of Ducie exhibited a barley hummeller, fitted with a fan-blast, an addition which may be found to give greater efficiency to these recently introduced and useful appendages to barn-machinery. Mr. Cartmell's (of Liverpool) corn-kibbling machine, rewarded at the last Meeting, merits notice and commendation for its excellent workmanship, and for the method of regulating the distance between the rollers, by which they are set closer or wider, and always kept parallel with each other; instead of being ill-adjusted, as they commonly are, by a screw at each end.

Turnip-cutters.—A variety of turnip-cutters was produced, and the premium was awarded for an implement constructed by Messrs. Sanders and Williams, of Bedford. It was not, however, without much doubt and hesitation that the judges determined on assigning this prize to any one of the competing makers. They feel that the turnip-slicer is a machine of such consequence to agriculturists, that a marked preference—of which a premium is the index—should only be accorded after a trial of the most satisfactory nature; and this cannot be instituted in the month of July, nor in the show-yard of the Meeting. The only proper site for determining the qualifications of these implements is the field, and during a winter's season. It would then infallibly appear which among rival machines was preferable, on a trial with roots in a soft and a frozen state, and under the circumstances of great quantities being required for daily use. The machine which worked with the least labour, made the least waste, &c., would then manifest its qualities, and a safe judgment could be pronounced.

To Messrs. H. and T. Proctor, of Bristol, a prize of 3*l.* was awarded for a turnip and chaff cutter combined, so as to produce, at a single operation, a mixture of the two kinds of food, or each could be worked separately.

Churns.—No churns were exhibited.

Cheese-pressers.—The premium of 5*l.* was awarded to Mr. W. J. Gingell, of Bristol, for his cheese-presser, as it appeared to possess, in a superior degree, the properties of simplicity, and of adaptation to the capacity of the dairy-maid. The force is derived from a single lever, with moveable weights. The action on

the cheese is constant, and its amount can be regulated at will. This press is, probably, more suitable for a small than a large dairy, and where one cheese only is under press at a time. Other well-contrived presses, and of a more powerful kind, were exhibited; the judges highly commend the machine constructed by Mr. J. Wright, of Glastonbury, which ingeniously combines the use of the screw with the continuous action of compound levers.

Hay-making Machine.—The hay-making machine invented and constructed by Mr. James Lovell, of Glastonbury, was selected as well deserving the premium of 10*l*. This implement does not, like those in more general use, take the grass or hay round upon the rakes, and throw it over in the air, but simply turns and spreads it. The teeth are straight, and not likely to become clogged. For travelling they are turned in towards the axle. The four rows of teeth are fixed upon a shaft which revolves immediately over the main axle of the carriage, from which it receives its motion. The rakes, therefore, adapt themselves to the inequalities of the ground, by ascending and descending with the carriage-wheels. The pinion on each end of the rake-shaft gears into a cog-wheel with inside teeth fixed to the carriage-wheel, and are well protected from clogging. By this arrangement the rakes revolve in the same direction as the carriage-wheels, and leave the grass spread behind them as the machine advances. Both pinions are moveable, and are readily disengaged or put in gear by the driver, who sits on a seat attached to the fender, so that either carriage-wheel can be made stationary when the machine has to be turned round. It is calculated for spreading about 5 acres per hour.

Horse-rake.—The premium for a horse-rake was again awarded to Mr. J. C. Grant, of Stamford, for the same excellent implement originally exhibited at Liverpool. The inventor has further improved it by substituting an iron for a wood bar, to carry the levers, by which change greater durability and more certain action are ensured.

Harrow.—To Mr. B. Wright, of Cardiff, the prize of 5*l*. was accorded for a harrow, the invention of Mr. Evan W. David of Radyr Court, constructed on the rhomboidal principle, and dividing the soil in rows 1½ inch asunder. Much ingenuity was displayed in combining several harrows together, so as to accommodate them to ridges, and to cover a large breadth of land. These, as well as some hollow iron swingle-trees, by the same maker, were remarkable for their lightness, strength, and good workmanship.

Potato-steamer—Clod-crushers.—Amongst the miscellaneous articles there was much to occupy the attention of the judges. Mr. Crosskill's collection contained a simple and well-arranged portable potato-steamer, the whole of metal, which was considered

to be worthy of reward. Mention must also be made of an improvement in his well-known and valuable clod-crusher. In the original implement the axle was square, and revolved with the bruising rims. Mr. Crosskill has since substituted a cylindric axle, upon which each rim turns freely. This change has improved its effect, particularly for rolling growing wheat in the spring of the year, for which purpose it is much used on light soils. The injurious screwing or twisting action on the soil and plants in turning the machine round is prevented by this new arrangement.

Mr. Joseph Hall, of Cambridge, drew the attention of the judges to an implement also designed for clod-crushing. It may be described as a large spiral, with jagged peripheries, wound round a shaft or axis, and resembling a screw. The practical effect of this arrangement could not be ascertained, as the implement was in an unfinished state; but its principle of action seemed not unlikely to produce the desired result, and merits trial.

Furrow-presser.—A two-furrow presser, by Mr. Crosskill, with drill attached, is much used in Yorkshire and Lincolnshire, and found to be a very advantageous implement for depositing wheat and manures. It follows two ploughs.

Threshing-machinery.—A premium of 5*l.* was awarded to Mr. S. J. Knight, of Maidstone, for a new method of communicating rotary motion to threshing-machines by hand labour, the invention of Mr. Joseph Barling, of Maidstone. The means used may be described as resembling the lever power adopted in fire-engines, only placed at a greater height, so that the weight of a man's body combines with his muscular force to produce the effect. This arrangement was ingeniously managed, and the machine was worked with more apparent ease than with the winch. It remains steady during work. It is proper, however, to observe that the judges had not the opportunity of ascertaining its effect when actually threshing. Mr. Crosskill's method of adjusting the concave to the drum of threshing-machines deserves commendation. By its means the concave cannot be approached too near the drum, so as to break the grain; and the employer has the advantage of observing the position of the concave, and of altering it without the trouble of stopping the machine. A prize of 5*l.* was given to Mr. Edward Plenty, of Newbury, for a substantial and durable arrangement of the horse-machinery for driving portable threshing-machines. The whole is of iron, very compactly put together, and readily fixed for work. The horse-machinery of threshing-machines, constructed by Messrs. Garrett and Son, of Saxmundham, was also of an improved order, particularly the large iron segmental wheel, which is so contrived that any one segment can be renewed by the attendant in the event of a tooth being broken. The bolting-machine of the same makers, for threshing wheat without

breaking the straw, is a valuable implement for the suppliers of straight straw for the London and other markets.

Flour-mills.—Domestic flour-mills have, perhaps, not yet received that encouragement from agriculturists which they merit. Two good machines were exhibited by Mr. Alexander Dean, and Mr. Zachariah Parkes, both of Birmingham. A premium of 5*l.* was adjudged to Mr. Dean for his grinding and dressing mill, which was applicable to hand, steam, or animal power. These improved metallic mills are now made cheap and durable, and will form an economical appendage to the farmer's stock of domestic machinery. They are, also, well adapted to the circumstances of colonists and emigrants.

Dynamometer—Netting for Sheep-folds—Hatching-apparatus.—To Messrs. Cottam and Hallen, of London, a reward of 5*l.* was considered to be well deserved for their dynamometer, or draught-gauge. This is an instrument of great value for ascertaining the resistance of ploughs and other implements of culture; and experience has sanctioned its sufficiency to measure, with a near approach to accuracy, the amount of force derived from the peculiar action of the draught-horse. With careful management it is little subject to derangement. The same makers exhibited a specimen of netting for folding sheep, spun from the fibre of the cocoa-nut, a material known to possess very great durability when exposed to alternations of weather. A premium of 3*l.* was adjudged to Messrs. Wildey and Co., the manufacturers, of Holland Street, Blackfriars, London, in the hope of encouraging the introduction of a more lasting article than hemp for this purpose. An elegant apparatus for hatching and rearing game and poultry, the invention of Mr. Appleyard, also appeared in the collection of Messrs. Cottam and Hallen, which recommends itself by its simplicity, moderate dimensions, and apparently easy regulation of the requisite heat, supplied by a small oil-lamp. This invention is well worthy the attention of poultry rearers, as well as of the proprietor of game-preserves.

Carts and Waggons.—The show-yard was rich in an assortment of carts and waggon. To Mr. Richard Stratton, of Bristol, a premium of 10*l.* was assigned for the extraordinary variety and good workmanship of his immense collection; more particularly for the ingenuity displayed in the construction of a cross-lock waggon, which facilitates its turning in a very small space, and permits the use of four large wheels of equal diameter. A tipping waggon also possessed much mechanical merit, but it is to be recommended as better adapted to commercial than to agricultural use. Mr. Stratton produced an excellent specimen of the low-chested cart, obtained by cranking down the axles, now in such general use by mercantile men and shippers. This

disposition, modified to suit farming purposes, well merits the attention of agriculturists, as it would greatly ease the toil of the labourer. Of Mr. Hannam's (of Burcot) unequalled one-horse harvest-cart, described in vol. ii. of the Journal of the Society, more need not be said than that it cannot be exhibited too often, and that it ought to be found on every farm. To Mr. Robert Law, of Shettleston, near Glasgow, a prize of 3*l.* was awarded for his Scotch one-horse tipping-cart with a spring catch to retain it on the shafts. This simple little contrivance is much preferable to pins and cotters, which are apt to shake out, or to be neglected in the fastening, by which the load is not unfrequently let fall.

Self-acting Brakes.—A reward of 5*l.* was given to Messrs. C. and T. Thatcher, of Midsomer Norton, near Bath, for their cart with patent self-acting and self-regulating brakes. Two light chains are attached to the breech-band of the horse, one on each side, which pass round a pulley on the respective shafts, and are thence brought back to the cart, where they are hooked to levers which act with clips against friction-hoops staked on the inside of each wheel-nave. When the horse backs on going down a declivity, he causes the clips to press against the hoops with sufficient force to stop or regulate the velocity of a loaded cart descending the steepest hill. This contrivance promises to be a highly useful appendage to carts in hilly districts. It is also applied to waggons and pole-carriages.

The judges regret that the show-yard did not furnish a single specimen of a waggon or one-horse cart on springs, so much used and approved by the manufacturers of Lancashire and Yorkshire, and so well adapted, as they would be found, for the economical and speedy conveyance of farm-produce to market.

Portable Forge.—Amongst the miscellaneous items in the collection of the Earl of Ducie, a light portable smith's forge was exhibited, the invention of Mr. Richard Clyburn, which deserves notice and commendation, as useful to the owners of extensive estates and farms lying distant from a forge or town. The whole weighs about 8 cwt., is compact, and of easy transport. It is specially remarkable for the adaptation of a small fan, instead of bellows, turned by a boy, and affording a blast sufficient for welding a 3-inch bar. The substitution of a fan remedies the great evil hitherto attaching to portable out-door forges, from the rapid decay of bellows. This implement is admirably suited to the wants of the emigrant and of settlers on waste lands.

Draining-tools and Tile-machine.—There was no collection of draining-tools answering to the terms of the Society's offered premium. A tile-making machine of much merit, the invention of Mr. Wm. Irving, of Lambeth, was exhibited by Mr. Ford, of Nine Elms, Vauxhall. This implement was overlooked by the judges

till after the award of the prizes was rendered to the Council. A subsequent examination and trial of its powers proved that it would have been well entitled to a premium, as contributing to diminish the cost of an article so essential to agriculturists. The machine is remarkably simple and cheap, turning out sixteen draining-tiles, and twice that number of soles, at once. It may be safely reported as capable of producing, from well-prepared clay, 5000 tiles per diem, by the labour of one man and four boys.

Steam-engines.—Four steam-engines adapted to give motion to implements in the barn were exhibited. Messrs. Ransome's collection contained the excellent portable disc-engine (tried at Liverpool), now set upon a carriage with four instead of two wheels, and having a platform of sufficient dimensions for the conveyance of a threshing-machine from farm to farm. A further change had been made by applying the power of the engine to give locomotion to the carriage, instead of using horses.

A small and cheap engine, nominally of two-horses' power, also furnished by the Disc-engine Company of Birmingham, and occupying a space, including the boiler, of only about 12 square feet, was exhibited by the same firm. This engine is not mounted on wheels, but requires neither masonry nor any kind of foundation for fixing it.

Mr. Cambridge, of Market Lavington, Wilts, produced a very complete portable engine, with boiler, on four wheels. This engine, of about four-horses' power, is of the vibrating or oscillating kind, and did great credit to the maker, from the simple arrangement and good workmanship of all its parts. It was connected with a threshing-machine from the same workshop, conveyed about separately.

Mr. Alexander Dean, of Birmingham, exhibited a portable engine, in connexion with his flour-mill, and intended for the general purposes of the barn; but as it was not shown in action its qualities could not be ascertained.

In order to be able to decide on the particular merits of the three first-named engines, as well as of some powerful chaff-cutters, and Mr. Crosskill's portable saw-mill, the judges attended at Frenchay, the seat of Mrs. Rooke, who very obligingly permitted these trials to be conducted on her premises. Both Messrs. Ransome's and Mr. Cambridge's engines performed their work of threshing in a satisfactory manner; and the small disc-engine proved itself to be sufficiently powerful to drive at full speed a three-horse threshing-machine. The judges, in consequence, awarded to Messrs. Ransome a prize of 30*l.*, and to Mr. Cambridge the sum of 15*l.* They consider it questionable whether the substitution of steam for horses, as the force employed

to move portable agricultural steam-engines from place to place, will be found either more convenient or economical; they cannot, however, but highly commend the simplicity and effectiveness of the machinery applied by Messrs. Ransome to accomplish this purpose. The engine travelled along the road at the rate of from four to six miles an hour, and was guided and manœuvred so as to fix it in any particular spot with much ease; it turned also in a very small compass.

Portable Saw-mill.—Mr. Crosskill's portable saw-mill is to be commended as an implement adapted for the use of gentlemen having much light timber to cut up into rails, or for other uses, and seems to be well calculated, when driven by the portable steam-engine or horse-power, to economise labour and the cost of transport on a large wooded estate. The saw is of the circular kind, and the machine is furnished with a grindstone, and with augers to bore holes, all moved by power.

Chaff-cutters.—The show-yard abounded with excellent chaff-cutting machines, of all sizes, fashions, and capabilities. Three, of the most powerful description, were selected for trial in connexion with the steam-engines; but as the judges could not discover any marked improvement over those produced and reported upon at the Liverpool meeting, to justify the singling out of any one of them for the Society's prize, it was not assigned. A premium of 3*l.* was adjudged to Mr. James Richmond, of Salford, for a small chaff-engine, of a novel and peculiar kind, patented by Mr. Worth, an American. The action of this machine is perfectly continuous, the cut being produced by the pressure of straight-edged knives, fixed at equal distances asunder, on a bottom roller, in the direction of its length, and working against an upper roller composed of a mixture of lead and zinc, between which the straw or hay is drawn in a regular stream. In principle, this machine may be considered to be diametrically opposed to that which has hitherto guided mechanics in the construction of chaff-cutters; but as it appeared to be worked with remarkable ease, and to cut with a cleanness never yet excelled, or, perhaps, equalled, it was deemed to be entitled to reward, and to the favourable notice of the Society. At present, the maker seems to have limited the dimensions of the machine to suit the demands of small consumers: experience will determine whether the same principle can be extended to meet the wants of the large farmer, and whether, in respect of durability, it equals the better-known machines.

Chaff-cutters, now in universal use, have so largely partaken of the attention and skill of mechanics, that the task of deciding on their respective merits is become far too difficult for any judges whose time is restricted to the short period allotted to the

examination of the Society's show-yard, and whose attention is demanded by such a vast assemblage of implements. The quality of the work done can be tolerably well appreciated in the yard, but the quantity performed in a given time, and with a given force—upon which facts a decision as to economy, and the most effective construction, must be grounded—can only be ascertained by trials of sufficient length and exactness.

Subsoil-pulverizers.—The collections of most of the larger machine-makers contained specimens of subsoil-ploughs, efficiently constructed after well-known models. Of these it is unnecessary to make particular mention. Three implements of this class were selected for trial, which deserve special notice.

The Honourable M. W. B. Nugent, of Higham Grange, near Hinckley, Leicestershire, exhibited an implement of his own invention, which may be correctly termed a *subsoil-pulverizer*, as its object is to undermine, break, and stir the subsoil, without raising it to the surface, which latter is the specific function of the *plough*. These two operations are distinct in their intent and nature; it would appear, therefore, to be more correct to designate the implements used for the two purposes by distinct and appropriate names. Mr. Nugent's subsoil-pulverizer consists of several strong curved coulters, or teeth, so fixed to the beam of the implement as to work under the soil at unequal depths, and at distances varying from each other both in length and breadth. Thus, the mass to be broken up is not opposed to the action of a single blade, as in the common subsoil-plough, but is cut and disturbed by the successive action of several blades, which penetrate, loosen, and move the soil to the respective depths at which they may be set to act; for which purpose, and to suit various soils, each tine is made adjustable. The implement submitted to trial, which was the first yet constructed, had four blades operating in succession, at six, nine, twelve, and sixteen inches in depth, moving, pulverizing, and incorporating the soil to that depth, and to about twelve inches in the transverse section. It is furnished with two leading, and two hind or trailing, wheels, for the following purposes:—First, for assisting in the regulation of the depth stirred; second, to travel the implement; third, to raise the teeth out of the ground at the end of a bout. Much ingenuity and good workmanship were displayed in bringing about these ends, and in accomplishing, by the hand, and at the will of the holder, an instantaneous change in the working depth of the blades.

Some of the mechanical details of this implement were not in a complete state, and its action, therefore, not so certain and perfect as is desirable; but the judges had no hesitation in awarding a prize to the inventor, as the quality of the work done seemed to them to justify the correctness of the principles which had guided

him in the construction of an important implement; and its defects did not appear to be other than might readily be rectified by a skilful mechanic, aided by the light of further experience in its use.

Mr. Pusey's plough, which has received the name of the "*Charlbury Subsoil*," was also tried. It is a common wheel plough, having a single tine or stirrer attached to its hinder part, which descends a few inches below the sole, and is intended to loosen the soil in its track, deepening, and to a limited extent pulverizing, the stratum beneath. This modification of a subsoil-pulverizer has the advantage of simplicity and cheapness, and the combination may be usefully employed on light soils, and by farmers possessing only a limited command of team.*

Trenching and Subsoil Plough.—To Mr. Law, of Shettleston, near Glasgow, a prize was awarded for a trenching and subsoil plough combined. This implement performed its work very satisfactorily, with a team of six horses, trenching in one direction, and subsoiling in the returning one. A trenching-furrow having been cut, the mouldboard or wrest is turned up out of the way, by means of the same simple mechanism as is adapted to Smith's (or Wilkie's) turnwrest plough. The implement is then reversed, put into the furrow, and the operation of subsoiling proceeds without unyoking the team. The trenching or deep-ploughing operation is performed on the left-hand side of the implement; and the spur or bar for breaking up the subsoil is placed, in returning, on the right-hand side; consequently, the force is applied on the same side as that on which the furrow-slice has been turned; and it seems reasonable to conclude that the resistance to be overcome must be less against soil already loosened than if working against the unbroken mass of the land side, as in Armstrong's trenching and subsoil plough. A leading wheel regulates the depth desired, by shifting up or down, so that a furrow may be trenched from 8 inches to 14 inches in depth, and the subsoiling effected, proportionably, to the extent of 20 inches below the surface of the field.

Surface-ploughs.—The following table registers the results of experiments made on a variety of ploughs, at the trial-ground, on Mr. Webb Hall's farm:—

* See a woodcut of this plough in the *Journal of the Society*, vol. iii. part i. p. 106.

Experiments on the Draught of Ploughs.

Makers' Names.	Residence.	Number of Horses.	Number of Wheels.	Slice cut.		Draught in Stones.	
				Depth, inches	Width, inches		
Howard	Bedford	2	2	6	9	22	Prize.
Mason	{ Grafton, near Leicester, } Warwickshire	2	2	6	9	26	Prize.
"	"	2	2	6	9	30	{ With two knives. Ditto, with skin coulter.
"	"	2	2	6	9	30	
Brayton	Carlisle	2	1	6	9	28	
Sanders & Williams	Bedford	2	2	6	9	30	
Carson	Warminster	2	1	6	9	32	
Mason	Grafton	3	2	6	9	60	Double furrow. Ditto.
Barrett & Co. . .	Reading	3	2	6	9	60	
Huckvale . . .	Over Norton, Oxon. . .	2	{ foot or floater }	6	9	36	Turnwrest.
Earl of Ducie . .	Uley	2	swing	6	9	26	Prize.
Howard	Bedford	2	"	6	9	26	
Brayton	Carlisle	2	"	6	9	28	
Carson	Warminster	2	"	6	9	32	
Merrett	{ Appleadon, near Newent, Gloucestersh. }	2	"	6	9	32	
Law	{ Shettleston, near Glasgow }	2	"	6	9	36	
Wilkie	Uddingston, ditto . .	2	"	6	9	44	Turnwrest.

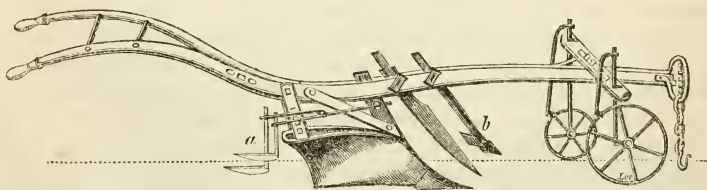
With respect to the excellence of the work done by these ploughs, as well as lightness of draught, the palm of merit is unquestionably due to Mr. Howard's two-wheel implement; the furrow-bottom being left cleaner and flatter, the slice better turned and placed, and the depth more evenly maintained, than by any other of the competing ploughs. The dynamometer exhibited a peculiar steadiness of movement and uniformity of draught in this plough; and the same qualities were distinguishable as belonging, in a superior degree, to all the wheel, compared with the swing, ploughs. The remark made in recording the experiments at Liverpool, viz. that the weight of soil actually raised by the wheel-ploughs was, in every case, greater than that turned over by the swings, is equally applicable on the present occasion, inasmuch as all the swing-ploughs leaned more or less to the land side, and did not maintain so even and horizontal a bearing on the sole as the wheel-ploughs. The two kinds of plough from the same workshop, of which there were three different pairs in the field, manifested these qualities in every case. Two better ploughs than Mr. Brayton's have rarely been put into the ground; and they were held by an experienced and skilful ploughman of Mr. Falkner's of Fairfield, near Liverpool; but the work of his one-wheel was decidedly superior to that of his swing plough, though the draught of both was alike. The same may be said of the performance of Mr. Carson's and Mr. Howard's implements; and it is worthy of note, that the resistance of Mr. Howard's two-wheel

was less than that of his swing plough by 4 stones, the latter equalling a new and very elegantly constructed swing-plough from the workshop of the Earl of Ducie, to whom the prize was adjudged, as the quality of the work done by the latter was considered to be superior, in a slight degree, to that of the other ploughs of this class.

Surface pulverizing plough.—The judges have to report, in addition to the trials of these well-known varieties, the performance of an implement constructed by Mr. Mason, of Grafton, Warwickshire, which, as a common wheel-plough, did excellent work; but its peculiarity consisted in the addition of pulverizing knives attached to moveable bars, or rods, extending beyond the end of the mouldboard. These knives are used in suitable soils for cutting off the angular summit of the furrow-slice just raised, and dividing it into two, or, if requisite, into three portions. Having ascertained the draught of this plough in its ordinary state (*see* woodcut, fig. 1), one of the knives, *a*, was put in work to about the depth of 2 inches below the surface of the slice; and then a second knife, acting at a somewhat greater depth below the upper one. Under these conditions the dynamometer exhibited an increase of draught of 4 stones, or a little more than 15 per cent. The skim-coulter, *b*, was then set down to the depth of about an inch: this did not appear to cause any increase of resistance.

The woodcut shows the plough in perspective, with sufficient accuracy to illustrate the position of the knives, when out of work, and the simple arrangements for holding them and adjusting their depth of cut. Their shape is as drawn, but it will be understood that, when at work, their curved cutting edge is presented, at an angle more or less acute, to the furrow-slice, which is divided horizontally, in the plane of the plough's path.

Fig. 1.



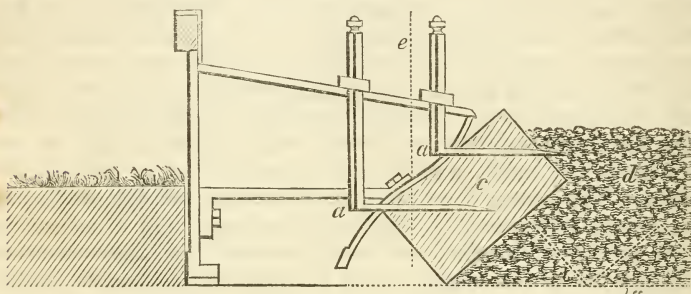
The character of the soil upon which the trials were made was that of a sandy loam in a good mellow state, a crop of strong clover having been cut from it on the preceding day. The appearance given to the surface of the ploughed land by the action of the knives was that of a well-harrowed field, the soil being left loose and pulverized nearly to the depth turned up.

The action of the plough was in no respect deranged by that of the slicers; it "swam fair" on the furrow bottom, leaving it clean and flat, and required so little skill in guidance, that Mr. John Stokes, of Pauntley Court, the exhibitor, who held the plough, frequently left it free for a long space to follow the horses. It possessed, therefore, like other well-constructed wheel-ploughs, those properties approaching to self-action, and government, which must be acknowledged to be no less essential to the perfection of an agricultural implement than to the steam-engine, the lathe, and machinery of all descriptions. It has been noticed that the great amount of pulverization effected by this simple combination of two knives with the common plough was obtained at the comparatively slight additional cost of 15 per cent. of animal force; the whole draught of the plough, in this state, not exceeding that of several other good ploughs in the same soil, and being within the compass of the power of two horses. The judges were of opinion that the soil operated upon was as well pulverized by this single process, and to as great a depth, as if first ploughed and then harrowed; and they trust that subsequent experience may justify the expectations formed on the ground, that, by means of this remarkably simple combination, no unimportant economy and advantage may accrue to the farmer in pulverizing turnip and other soils preparatory to drilling the seed.

Fig. 2, drawn to a scale of 1 inch to the foot, represents the tail-part of the plough, and shows the knives *a a* in their working position. A furrow slice, 6 inches deep by 10 inches wide, would, if composed of perfectly coherent and elastic materials, assume the shape shown in section at *c*. Such, however, never is nor can be the case in practice with soil of any description. The slice of earth operated upon by a plough, whilst being raised from its horizontal bed, and forced into its new and oblique position by the torsion of the mould-board, is irregularly extended, and much loosened, or broken, owing to the imperfect cohesion of its particles, and to the absence of elasticity. It would, therefore, appear that the instant seized, and the place chosen, for assisting in the further disintegration of the slice by the action of the knives, are precisely those when its existing condition permits the greatest amount of pulverization to be effected, and with the least expenditure of power. The crumbling effect produced by severing each slice in detail, before it is pressed by the succeeding slices into a compact mass, and left to dry and harden, is analogous to the manipulations of the gardener, who bruises and pulverizes each spadefull of earth as he throws it up from the trench, and thus spares himself much subsequent toil, and his work much injury, by diminishing the after labouring and trampling

on its surface to fit it for seed. The state in which the soil is left by this plough is attempted to be delineated at *d*; but it is evident that the degree of pulverization obtained will necessarily vary according to the greater or less friability of the particular soil acted upon, and according to its condition at the time of ploughing. Upon these circumstances depend both the figure of the furrow-slice *c*, and the extent of its dismemberment effected by the knives.

Fig. 2.



Mr. Stokes, who has continually used this plough since 1839, in soils varying, as to tenacity, from light sand to stubborn clay, describes the appearance produced by the action of the knives on *stiff adhesive soils* to be that of a well spade-dug field, only that the work is more evenly and better performed, and that a sufficiently fine tilth is obtained, even on such soils, for the reception of seed to be drilled, without the use of the harrow, and with the further advantage of avoiding the poaching and trampling incident to it. The harrow is, unquestionably, the rudest and least efficient of all agricultural implements, and a promise seems at length to be held out that, in the preparation of land for subsequent drill husbandry, its use may be occasionally dispensed with; nor does it seem unreasonable to expect that a single ploughing, with the knives, may, on some soils, save the time and cost of a second ploughing.*

Double-furrow and turnwrest ploughs.—The two double-furrow ploughs, the draught of which is recorded in the foregoing Table, were not in perfect trim for work. It is much to be desired that on future occasions the exhibitors of these implements, which are so much approved in certain districts, and on particular soils, would take the precaution to have them sent to the ground previously well set, and be provided with holders accustomed to their management. Others were also tried, but their draught was not

* For additional information respecting this invention see the end of this Report, p. 363.

taken, owing to the want of these precautions. The Society's prize was not awarded for these, or for the turn-wrest ploughs. Two of the latter kind were tried—the one made by Mr. Huckvale, the other by Mr. Wilkie—but neither of them were in a condition to satisfy the judges that a correct decision on their merits or draught could be arrived at. Mr. Wilkie was not present, on account of illness.

Ploughs of other kinds were also submitted to trial, but nothing worthy of note was elicited.

Draining and paring ploughs.—The premium offered for an open-furrow draining-plough was not adjudged. The show-yard contained one implement only of this kind, by Mr. James Comins, of South Molton, which was not tried. Mr. Johnson, of Leicester, exhibited Mr. Glover's excellent turf and stubble paring-plough, rewarded at Liverpool, which the judges were pleased to learn has met with the encouragement it merits.

In concluding these comments, the judges must express their consciousness that, owing to the insufficient time allotted for examining minutely so extensive an assortment of implements, they may have overlooked, or omitted the mention of, meritorious productions. Some implements, not rewarded, may also have been esteemed by visitors equal or superior in excellence to those which carried prizes; and it is requisite to state that, for reasons unexplained and undiscovered, the show-yard contained numerous implements which were not entered for competition: of these, therefore, no note was taken, as they did not pass under the observation of the judges.

Observations on Ploughs.—Much useful instruction may be drawn from the experiments on the draught of ploughs, and on the quality of the work performed, now annually made at the instance of the Society. The mean resistance of the five wheel-ploughs registered in the foregoing list was 386 pounds, whilst that of the six swing-ploughs was 420 pounds, being a difference of nearly 9 per cent. in favour of the wheel-ploughs; and the difference in the resistance of the best implement of the two kinds was 18 per cent. in favour of the wheel-plough.* It may also be safely affirmed that the quality of the performance in the same soil, by the respective ploughs, and under like circumstances of depth, width of slice cut, &c., is as the lightness of draught, *i.e.* in favour of the plough of least resistance.

On this occasion the judges took the precaution, after the trials, to suspend weights to the dynamometer, in order to verify the accuracy of its graduation, and to ascertain if any change had

* The draught of the double-furrow and turnwrest ploughs is not included in this estimate.

taken place in its indications during the experiments. The instrument was found to have given strictly correct results throughout the range of the draughts noted. It is also proper to state that the ploughs, after being got into trim, were successively brought to the same part of the field, and the indication of the force was recorded at the time of each plough's passage through similar soil, the pace being as nearly as possible alike in every case. The nature and form of the field selected for the purpose compelled the judges—at a considerable loss of time—to adopt this plan, as the quality of the soil varied materially in different parts, and the sharp slope of the ground in some parts of it would have rendered the experiments nugatory if the force of draught had not been taken pretty nearly in one locality.

An analysis and comparison of the results obtained at Liverpool, and Bristol, disclose facts of no slight importance to the agriculturist and the ploughwright. The difference between the mean draught of the wheel and swing ploughs at the former trial was 17 per cent. in favour of the wheel-plough, and there was an equality in this respect between the best implement of each kind. At Bristol, one maker, Mr. Howard of Bedford, produced a wheel-plough which beat his own swing by 18 per cent., the latter being equal to the best on the ground. At Liverpool, the difference between the maximum and minimum resistance of the ploughs was nearly 43 per cent., whilst at Bristol it amounted to $63\frac{1}{2}$ per cent.; in both cases in favour of the wheel-ploughs. Whatever may be the cause of this enormous irregularity and disparity in the force required to perform work identically similar, it is apparent that the expenditure of animal power, and its cost to the farmer, are altogether dependent on the implement he employs, and proportional to the force used; also, that in the single operation of ploughing, he is frequently consuming at least one-half more power than is necessary to perform his work. The elementary resistance of any given sort of soil is a constant quantity, and the skill of the ploughwright should be exercised in the endeavour to diminish, to its minimum amount, the excess of force employed to move the implement over and above that which is absolutely requisite to divide, under-cut, raise, and lay the furrow-slice; all which operations are implied under the technical phrase *ploughing*. It is evident that, at Bristol, the difference between the extremes of draught required in the same soil by *wheel-ploughs*, and by those of the *swing* kind, was equivalent to a loss of power by the former of 36 per cent., and by the latter of 38 per cent.; and it resulted that a force not greater than 22 stones really sufficed to perform the same amount of work, or to produce the same useful effect, as a force of 32 and even of 36 stones, exerted by the same horses on other ploughs! The pro-

blem remains to be solved — by how much the least force used exceeds the resistance naturally and necessarily opposed to it? Its solution rests with the machine-maker, and it will be found in the application of sound mechanical principles to the structure of the implement, when combined with a true knowledge of the nature and amount of the several resistances to be overcome.

The following particulars of the weight and dimensions of some of the principal parts of the wheel and swing ploughs submitted to trial have been obligingly furnished by the makers, at the request of the judges, who think that a record of them may, at least, present useful matter of study to the enlightened mechanic, and possibly induce him to experiment, extensively and carefully, on the effects arising from any change of these proportions as regards resistance and quality of work. He will, at the same time, be naturally led to investigate the influence produced by the line and angle of draught, as well as by the length and twist of the mouldboard, and other properties which cannot be conveniently given in a table. The philosopher may meditate on these matters, as questions of interesting research; but the mechanician alone can arrive, through observation, experiment, and practical skill, at the construction of a perfect plough. A rich harvest of fame and profit awaits his labours; he may now work in confident security that the productions of his genius and industry will no longer—like the pulverizing plough—risk interment and oblivion in some corner of a secluded parish; the Society offers him a fair and honourable field for the display of his labours, and its hand is open to encourage, reward, and proclaim them:—

Makers' Names.	Number of Wheels.	Length from point to heel.	Width at the heel.	Greatest width of Share.	Length of Share on the land side.	Weight.
		Inches.	Inches.	Inches.	Inches.	Lbs.
Howard . . .	2	35	8½	8	9	220
Mason . . .	2	34	10	6½	10	252
Brayton . . .	1	32½	7½	6	10	196
Sanders and Williams	2	36	6½	9	9	245
Carson . . .	1	38½	6½ } 10½ }*	8½	12	193
Huckvale . . .	—	29	9½	9	12½	150
Earl of Ducie . .	Swing	27	8	6	9½	161
Howard . . .	do.	33	9	8	9	137
Brayton . . .	do.	30	6	5½	9	112
Carson . . .	do.	38½	6½ } 10 }*	8½	12	174
Merrett . . .	do.	38	9½	6¾	9	148
Law . . .	do.	32½	8	6½	12	170
Wilkie . . .	do.	36	7½	7½	12	230
				†	†	

* Moveable.

†† The cutting angle of the share is given by these two columns.

The judges trust that the importance of this subject will be a sufficient excuse for the space devoted to it; they feel it to be their province and duty to elicit, for the information of the Society, all such truths as the experiments committed to their management may develop; and they do not hesitate to express their conviction that, if arrangements could be made at future Meetings for a still greater extension of the time and means allotted to the trial of field implements, previous to the declaration of prizes, the zeal of constructors would be greatly encouraged, and the objects of the Society more rapidly and surely promoted. The experience acquired by their having acted on several similar occasions induces them also to recommend that exhibitors be invited, as *a condition of trial*, to send their ploughs and machines in the best state for work, so as on future occasions to save the time of the judges, and to evolve more correct and useful results. It is evident that the acting parts of an implement put into the ground for the first time, or recently painted, are in a most unfavourable condition to fulfil one at least of the purposes of a trial, viz. the determination of its draught; and it is possible that the best implement may be in the worst trim for work. It is requisite too that the maker, or some authorized and sufficient representative, should be present to manage his own implement. Several implements, the ocular inspection of which gave promise of novel merit, remained untried, or very imperfectly tried, at Bristol; whereas others, equally novel, had their principal qualifications and advantages sufficiently ascertained for the judges to report upon with satisfaction to themselves and to the inventors.

The justice of these remarks will be appreciated by all who witnessed the skilful management of Mason's plough by Mr. John Stokes, and the perseverance of the Hon. Mr. Nugent in bringing his untried subsoil-pulverizer into such working condition as to enable the judges to prognosticate favourably of its future efficiency. If the trials had produced no other result than that of directing the attention of the Society to these two implements in particular—of the merits of which no sound opinion could have been formed had they not been *practically ascertained in the field*—no inconsiderable advantage will have been derived; but it is a matter of regret to the judges that they were unable to carry out to a much greater extent, and with greater precision, the objects of the Society in instituting these annual tests of the advance made in the science of agricultural mechanism.

JOSIAH PARKES.
GEORGE LEGARD.
R. S. GRABURN.

NOTE ON THE PULVERIZING PLOUGH.

The following particulars of the history, use, and experience of these slicing-knives have been obligingly communicated to the judges by Mr. John Stokes, of Pauntley Court, near Newent, farmer; by Mr. Allen Stokes, civil engineer, of Harvington, near Evesham; and by Thomas Brown, Esq., a magistrate of the county of Warwick, residing upon and farming his own estate at Kinwarton, near Alcester. The statement of these gentlemen is corroborated by Mr. William Mason, the maker of the plough exhibited at Bristol.

The knives were invented by Mr. Brown, who employed the father of Mason, a blacksmith, to fit them to a plough about twenty years ago. Mr. Brown originally placed one knife vertically, and another horizontally; but, finding the latter position to be most effective, he has continued to apply them in that form only; in which practice he has been followed by all who have since adopted them. Mr. William Mason at that time lived with his father, but afterwards engaged with a farmer as an agricultural labourer; and in his service acquired much skill as a ploughman, before settling himself at Grafton as a blacksmith and ploughwright.

In 1839 Mr. Allen Stokes altered the general form of the plough which Mason was then in the habit of constructing; and, particularly, for the purpose of providing for the proper adaptation and adjustment of Mr. Brown's knives. The first of these improved pulverizing ploughs was sent by Mr. Allen Stokes, in 1839, to his kinsman Mr. John Stokes, of Pauntley Court, whose farm contains between 300 and 400 acres of arable land (rented of Osman Ricardo, Esq.), and consists of turnip and barley soil, with a portion of wheat and bean land.

Mr. Brown states, from his long experience of the knives, that they are particularly useful in pulverizing his adhesive and very difficult soil, as they save the harrowing, and thereby avoid the poaching of the horses' feet; that he last year ploughed with them a two years' old turf, and drilled wheat upon it without previous harrowing, using only a one-horse harrow to cover the seed. Mr. John Stokes also observes that stiff clay land is not left cloddy by the action of the knives, but will be found, in many cases, fit for receiving the seed as they leave it. He agrees with Mr. Brown that, when the land is ploughed in an unkind state, perhaps one of the knives only may be found to work well; and, when the soil has been much trampled upon in wet weather, as on headlands, they will not work at all. In a mellow, friable soil it is the practice to place the knives near to the extremity of the mouldboard, so as to catch and divide the slice as it falls over; but in a stiff soil it is found more advantageous to set them farther off, so as to make their cut just after the slice has taken its bed; also, that the most perfect pulverization is obtained by turning over the slice much more obliquely than is customary, and even to reverse it as nearly as possible. Mr. Brown says, "I generally plough 8 inches deep and 10 inches wide with the knives. I now invariably use the horses in line in my stiff soil; nothing is so prejudicial as their treading out of the furrow. I have fully and fairly tried the horses abreast, but could not plough so well; the horses were worked too hard, and their trampling was very injurious." Mr. John Stokes uses the horses in both ways, according to the quality of the soil, and the strength required. Both the Messrs. Stokes and Mr. Brown state their opinion that the advantage of the two-wheel plough, when using the knives, is so self-evident, that there can be no question as to its superiority over the swing-plough for that purpose. Mr. John Stokes has applied them to a one-wheel plough, and it worked pretty well, but required holding; whereas, he observes, "the two-wheel ploughs, furnished with the

knives and well set, require no guidance, and will go without a holder." When it is thought desirable to reverse the furrow-slice completely, Mr. Brown is in the habit of using only the upper knife horizontally, and he applies a lower one in a vertical position (as shown by the dotted line *e* in fig. 2) so as to cut off about an inch or more of the inner or lower edge of the furrow-slice just turned, to allow room for the succeeding slice to fall flat over, or nearly so; and, under these circumstances, he ploughs shallower and wider.

With respect to the economy per acre arising from this process, Mr. Brown observes, that he has no account of the cost of the old system of ploughing and harrowing on his estate, having abandoned it for so long a period. He expresses himself as so convinced of the important saving and superior work effected by the use of the knives, that he employs them throughout his farms, and for every kind of crop. Several farmers in the neighbourhood of Grafton, who had been in the habit of using Mason's ploughs, have sent them to him to be altered to this new pattern.

XXVII.—*On the Public Institutions for the Advancement of Agricultural Science which exist in other Countries, and on the Plans which have been set on foot by Individuals with a similar intent in our own.* By CHARLES DAUBENY, M.D., F.R.S., Professor of Rural Economy in the University of Oxford.

IN the lecture which I last delivered before the University, my object was to explain the methods by which it might be possible for a person possessed of a moderate stock of scientific information, and of a few cheap and simple instruments of analysis, to determine the physical properties of the land he cultivates, and so much at least of its chemical constitution as would enable him to refer it to some one particular class and order in my proposed arrangement of soils.* But it is to be apprehended, that few practical farmers of the present day are provided with even that small amount of knowledge which such investigations presuppose, and that by most persons belonging to this class the very names assigned to the different constituents of the soil, and even to the qualities which we distinguish in them, are viewed, as it were, as an unknown tongue.

Hence, before we can hope to introduce the requisite degree of precision into the observations and reports of agriculturists, or to correct the vagueness of their present ideas and expressions, I conceive it will be necessary to furnish to those youths who are in after-life to take up husbandry as their profession some more enlarged system of instruction than is at present provided for them, and to see that, in addition to that familiarity with the daily routine of a farm which at present constitutes the principal pre-

* See the Table appended to my Lecture on the Application of Science to Agriculture, printed in the last Number of this Journal.

paration for the exercise of their intended calling, the elements of physical science, and a few of the leading principles of natural history, should be inculcated at a time of life when the mind is best capable of receiving them. And, lest it should be suspected that, in adopting such an opinion, I have been biassed by a predilection for the studies with which I have myself been principally engrossed, and that I am suggesting schemes, which, with reference to the practical ends of life, would be generally regarded as visionary and chimerical, it is my purpose to devote the greater part of the present lecture to an account of some few of those numerous public institutions which it has been judged by foreign governments expedient to establish in their respective countries, with a view to the very objects which I have just attempted to recommend as entitled to some consideration in our own.

In this general survey, which is, however, chiefly confined to those establishments which I have myself visited, I will begin with the neighbouring kingdom of France, where the promotion of agricultural science has for a long time past been regarded as an object worthy to engage the attention of the state.

On the Establishment at Grignon.

In the immediate vicinity of Paris is an agricultural institution, which, though in part supported by the subscriptions of individuals, receives nevertheless, to a certain extent, the countenance and aid of government.

It was founded in 1829, for the purpose of offering to young persons designed for husbandry an education partly of a theoretical and partly of a practical character, and at its commencement the only boon which was obtained from the nation consisted in the permission conceded to it of making use of one of the old royal palaces, that of Grignon, together with the domain attached, both of which on certain conditions were placed at the service of the establishment. The domain in question consists of about 474 hectares, or 1185 English acres, and comprehends a certain amount of arable, pasture, wood, and marsh land, in quality and value very various.

It was presented by the government to the institution, not as a free gift, but on the footing of a beneficial loan, the favourable conditions of which were conceded in consideration of the purposes of public utility aimed at by its projectors.

The principle, in short, upon which the institution was originally conducted seems to have been as follows:—A certain number of subscribers furnish capital enough to stock and cultivate the domain of Grignon, made over to them at a valuation by government. It is agreed that a rent of 5000 francs shall be considered due annually from the Company to the government, but that this

rent need not be paid in money, provided it can be shown to have been laid out in the improvement of the land itself. Thus, if after ten years the improvements effected upon the property shall be estimated at 50,000 francs, the Company will have complied with the terms of the agreement without any actual transfer of money into the hands of government.

Now the objects, in consideration of which the above terms were granted, consisted, in the first place, in exhibiting to the public the example of a better system of husbandry than that ordinarily adopted, and, in the second, in training up to agricultural pursuits a number of youths, by means of a system of education, which, besides its usual practical character, should also embrace the elements of general learning, as well as the principles of those sciences which bear some relation to the art intended to be practised by them.

Since, therefore, the director of the establishment stood to the Company in the relation of a bailiff to his landlord, the difficult problem imposed upon him was that of reconciling his obligations to the latter, with the understanding that a good and economical education should be supplied to the youths who desired to take advantage of the Institution. Accordingly, for some time after it had been set on foot, the Establishment laboured under embarrassments arising from this twofold character; the objects for which it had been founded, though apparently allied, being often found to clash one with the other, inasmuch as a due care to provide fit instruction for the students who resorted to it as a school of husbandry, often militated against the observance of that rigid economy which was necessary, in order to evince to the neighbouring farmers that the system pursued was more advantageous than their own: added to which, that the original contributors regarded their subscriptions in the light of an investment, rather than as a free gift to the public, and therefore looked to some return in the shape of interest for the capital they had supplied.

Accordingly, the director, M. Bella, in his Report for 1839, undertakes to show, not only that an interest of 4 per cent. had each year been paid to the subscribers, but also that the actual increase in the value of the property itself amounted in ten years to 145,852 francs, being more, by 95,852, than the amount originally stipulated for by government. This increase consisted in buildings, roads, &c. created on the estate, as well as in the superior productiveness of the land caused by the labour expended upon it. He admits, however, that in accomplishing this part of his duties he had been compelled to sacrifice in a degree the interests of the public, to whom the efficiency of the establishment as a school of agriculture was in fact the primary object; for, notwithstanding the sacrifices which had been made of a portion of

the profits of the farm to make up for losses entailed by the school, the salaries were too low to attract to the spot efficient teachers, and at the same time the terms of admission exceeded the means of the generality of students.

Under these circumstances, it is much to the credit of the director, that he should have dissuaded the Company from accepting an offer of direct pecuniary aid which had been tendered to them by the government, feeling, as he says, that the establishment would be discredited in the eyes of the neighbouring cultivators, as an example farm, if a part of the funds that maintained it were known to be derived from extraneous sources. But the same objection did not apply to the proposal subsequently made to them, that the payment of the professors should be at the charge of government—an arrangement which enabled the institution to obtain a higher grade of instructors, and likewise to lower the terms of admission from 1500 to 1200 francs for the higher, and from 1300 to 850 for the lower class of students; a sum equal to 48*l.* sterling for the former, and 36*l.* for the latter.

The present position of the Agricultural Institute at Grignon, and the views of its promoters, may therefore be summed up in the following words of the director, M. Bella, which are extracted from one of his published reports:—

“Instruction in husbandry may truly be said not to partake of the nature of those branches of education which admit of being pursued in the interior of large cities: it is at once so vast and so complicated, and it stands so much in need of an union of theory with practice, that the Chairs created in towns, though they may spread a taste for agriculture, cannot in themselves form expert husbandmen.

“If governments were to feel themselves called upon to carry on a system of farming operations in all its several departments, in order to test the soundness of theories by the results of practice, many difficulties would occur in the execution of their task, and a much more lavish expenditure must, if we may trust to general belief, be incurred, than would happen if the same were in the hands of individuals. It is more prudent, therefore, on the part of the state, that it should associate itself with some scheme already in the hands of individuals, and even here its intervention would be prejudicial, if its co-operation were proffered to establishments which did not present in themselves sufficient guarantees, and if the assistance it afforded were not to be confined within proper limits.

“Thus it would plainly be a fault for it to mix itself up with any scheme, which did not possess the conditions of duration necessary for the accomplishment of its proposed office; or which had not been proved to contain within itself the elements at least of suc-

cess; or, lastly, which did not promise to establish by its results, that the co-operation of the government was designed solely for the advantage of the country at large, and not to promote the individual benefit of the Company."

Such has been the line of conduct pursued by the French authorities with reference to Grignon—the nation merely coming in aid of a private speculation, so far as to supply means of instruction of a better kind, and at a lower rate, to the pupils who resort to it as a school of husbandry.

Nor was this aid afforded until the institution had proved its stability by meeting the engagements it had contracted; and when given, it was rendered in a way calculated, not to diminish the liabilities or to enhance the profits of the subscribers, but only to extend more widely the benefits of the institution, and to augment its means of diffusing agricultural knowledge.

The establishment in question purposes to accomplish more than can be effected by the ordinary system adopted for young men brought up to agriculture, who are sent to reside with some farmer living in a country celebrated for its successful husbandry, such as Norfolk, the Lothians, or Belgium—its aim being to form, not mere farmers, but persons competent to direct extensive farming establishments, who, like civil engineers, should be able at once, both to trace the plan of a system of culture applicable to the circumstances of each case, and likewise to direct the details of its execution. This is provided for at Grignon, by uniting such an amount of scientific knowledge as is scarcely attainable at a mere private seminary, with practical instruction, and a familiarity with the daily operations of the farm.

The means employed for effecting this twofold object are as follows.

For the purpose of imparting theoretical knowledge, courses of lectures are given on—

1. The rational principles of husbandry, and on the conduct of a farm.
2. The principles of rural economy applied to the employment of the capital and stock of the farm.
3. The most approved methods of keeping farming accounts.
4. The construction of farm-buildings, roads, and implements used in husbandry.
5. Vegetable physiology and botany.
6. Horticulture.
7. The art of foresting.
8. The general principles of the veterinary art.
9. The laws relating to property.
10. Geometry applied to the measurement and surveying of land.
11. Geometrical drawing of farming implements.

12. Physics, as applied to agriculture.
13. Chemistry, as applied to the analysis of soils, manures, &c.
14. Certain general notions of mineralogy and geology.
15. Domestic medicine, applied to the uses of husbandmen.

The practical part of the education, on the other hand, is conducted on the following system:—The pupils are intrusted in succession with all the different services of the farm. Some, for instance, under the direction of the professor of the veterinary art, perform the operations required by the casualties which are continually occurring in a numerous stock of cattle. Two young men are appointed as general inspectors, under the orders of the superintendent. Four are charged with the management of the oxen; two with that of the horses; two with the pigs; two with the sheep; two with the poultry; four with the silkworms: the duty of these respectively being, to note the accidents or cases of disease that occur amongst the stock committed to their care; to see that they are properly fed; and to mark any variations in their condition which may have been occasioned by differences in diet, &c.

Two pupils also are attached to the service of the garden; two to the woods and plantations; two to the inspection of the repairs taking place on the premises; two to the fabrication of starch, cheese, and other things made on the farm; two to the pharmaceutical department; two to the book-keeping and accounts.

In these cases it is usual to appoint a pupil of two years' standing in conjunction with one newly entered; and at the end of each week all are expected to make a report, in the presence of their comrades, of whatever had been done during the course of it in the departments to which they are severally attached. At the same time the professor, who presides over the practical part of their education, takes occasion to comment upon the proceedings, and to impart such information as flows naturally from the facts brought before him. He, moreover, takes the pupils to the spots where the various operations of the field are proceeding, in order to point out the fittest manner of executing them. It is his duty also to deliver a series of lectures on these different processes, at periods corresponding to those at which they are in actual progress. Nor is this the only kind of practical instruction here imparted; for each professor in his respective department is expected to give to his course, as much as possible, a practical turn: the professor of botany, for example, by means of herborizations; the professor of chemistry, by geological excursions; the professor of mathematics, by executing, on the plan he had pointed out, the survey and measurement of certain portions of land.

After being for two years thus trained in the theory as well as

the practice of all branches of rural economy, the pupils are expected to undergo an examination from the professors collectively, and, if this be satisfactorily gone through, are then presented with a diploma, certifying to their capacity for fulfilling the functions of what may be styled an "Agricultural Engineer."

One useful regulation in this establishment deserves to be briefly noticed, namely, that a daily register is kept of the amount of the manure obtained from the cattle of every kind which are maintained upon the farm, the whole mass being conveyed to a common receptacle, where it becomes mixed together, and brought into a condition suitable for putting upon the land. This practice is a great step towards obtaining such an exact estimate of the comparative amount of what is put on and taken off the land in the course of culture, as is requisite for testing satisfactorily the merits and defects of the system of husbandry pursued.

Few trials appear to have here been made of those several manures which have excited so much attention of late in England; but in fact the principles upon which the establishment is conducted almost preclude the superintendent from undertaking any novel experiments; and he moreover expressed to me his belief, that the greater dryness of the climate rendered saline substances less beneficial there than they are found to be to the soil of Great Britain.

On the Agricultural Establishments of Germany, &c.

If we proceed into Germany, it will be found that few of the leading states of which this vast confederacy is made up have neglected to provide, at the public expense, some institution or other designed for the improvement of agriculture.

In Prussia, the late king founded one on a large scale at Mögelein, in the duchy of Brandenburg, forty miles from Berlin, which, when visited by Mr. Jacob in the year 1820, had for its director the celebrated writer on rural economy, Von Thaer. It comprised at once a model-farm of 1200 acres, and a college for the instruction of youth. The education was partly of a theoretical, and partly of a practical description. The former was provided for by three professors, who lived upon the premises: one for mathematics, chemistry, and geology; one for the veterinary art; and the third for botany, and the use of the various vegetable productions in the materia medica, as well as for entomology.

The practical instruction was communicated by an experienced agriculturist, who undertook to point out to the pupils the method of applying the principles of the several sciences to the daily routine of husbandry. The course commenced in September: during the winter months the time of the pupils was occupied in the study of mathematics, and the six books of Euclid were mastered

by them ; whilst in the summer the knowledge thus obtained was applied to the measurement of land, timber, buildings, and other practical purposes. The first principles of chemistry were also unfolded. By means of a good but economical apparatus various experiments, either on a small or a large scale, were performed. For the larger ones, the brewhouse and the still-house, with their appendages, were found to be highly useful. Much attention was directed to the analysis of soils ; and the different sorts met with, distinguished according to the relative proportion of their component parts, were arranged on shelves with great order and regularity. The samples being severally contained in separate glasses, the latter were covered with yellow paper if the predominating ingredient were sand ; and had a white ticket on one side if the next in amount was limestone ; a red one if it were of a red clay ; and a blue one if of blue clay. Though an attention to these minutiae may appear to the more practical taste of Englishmen rather trifling and frivolous, yet it is stated that a classification, founded on this principle, is much in vogue on the estates in Germany, where statistical accounts are kept regularly.

There was an extensive botanic garden, arranged according to the system of Linnæus ; an herbarium, containing a large collection of dried plants ; a series of the skeletons of different animals connected with husbandry ; and models of agricultural implements, all open to the examination of the students. The various implements used upon the farm were all made by smiths, wheelwrights, &c. residing round about the institution ; and the pupils were allowed access to the workshops, and encouraged to make themselves masters, by minutely inspecting the implements, of the niceties of their construction. The sum paid by each pupil was 400 rix dollars (80*l.* sterling) annually ; besides which they were expected to provide their own beds and breakfasts, each having a separate apartment. It would therefore seem that the expense must, in a country like Prussia, preclude all but youths of good fortune from taking advantage of the institution.

In Mr. Jacob's opinion also the course of instruction was crowded into too short a space of time, many of the pupils studying there only for one year.

I have since been informed, that Mögelin is only one of many institutions of the same description which have been created under royal patronage in this kingdom, and that almost every province of Prussia may now boast of a public model farm and agricultural academy ; as, however, I have visited none of these, I must pass them over on the present occasion, and proceed to notice those existing in other parts of Germany. In the south of this country, the most flourishing establishment of a public nature connected with agriculture appears to be that of Hohen-

heim, in the kingdom of Wirtemberg, two leagues from Stuttgart, where an old palace has been converted into a sort of college for the reception of youth designed for husbandry. The palace stands upon an eminence, and has surrounding it, as it were, within a ring-fence, a considerable extent of ground, one of not less than 1000 acres. The soil is argillaceous, consisting of the upper beds of the *keuper*, which are marly, and of a bright red colour. There are here two classes of students, an upper and a lower division. The superior class pay, for their board 150 florins, and for their instruction 300 florins annually, together equal to 37*l.* sterling; and the extra expenses incurred are calculated as sufficient to increase the annual outlay to as much as 50*l.* Natives of Wirtemberg are, however, admitted at a still lower rate. The object of the higher school is to supply the great proprietors, or the managers of large estates, with the information necessary for enabling them to make the most of their land; and the plan of instruction therefore aims at combining theoretical with practical knowledge.

With the former intent the students are encouraged to inspect and superintend the several operations of husbandry carried on in the farm, though they do not, as at Grignon, take an actual part in them; and with the latter view twelve professors are provided, by whom lectures are delivered, on mathematics and physics, chemistry and botany, technology, tillage and other departments of rural economy, forestry, and the veterinary art.

The lectures are so arranged, that they can either be all attended in the course of two half-years, or may be made to occupy three or four; but to accomplish the whole within the former period, it is needful that a young man should bring with him much preliminary information, so that in general two years are spent at the academy.

Here, as at Mögeln, there is attached to the institution a small botanical garden; a museum of objects of natural history, in the three departments of zoology, botany, and mineralogy; a few skeletons to illustrate the anatomy of the horse, and of other domestic animals; a collection of seeds and of woods; and a library of works connected with agriculture. A manufactory of beet-root sugar, a brewery, a distillery of potato-spirit, and a small apartment devoted to the rearing of silkworms, are also comprised within this very complete establishment.

The inferior class of students are, in fact, field-labourers; but they have the advantage of hearing lectures on the several subjects taught at the college during those periods of the year when they can be spared from the duties of the farm. They pay little or nothing, but are maintained at the expense of the institution.

Besides the fields set apart for the ordinary methods of culture,

there is here a portion reserved for experiments; but I could not discover that it was applied to any further use than that of introducing specimens of plants not in general cultivation, which have been recommended on the score of their agricultural value.

At Grignon the director excused himself to me for not undertaking experiments, alleging, that his institution was supported by a number of shareholders, who naturally regarded it as an indispensable condition that the land should yield a profitable return; but he remarked, that as the institutions in Germany, such as those of Mögeln and of Hohenheim, were maintained by government, researches calculated to throw light upon the principles of agriculture might be expected to emanate from them.

I found, however, no attempts of this description at Hohenheim, nor can I discover from Mr. Jacob's account that any such were contemplated at Mögeln, even whilst it continued under the auspices of so enlightened an agriculturist as Von Thaer. Indeed I do not believe that a model and an experimental farm can ever go together, desirable as it undoubtedly is that they should occur in each other's vicinity, and I earnestly wish that the distinction between the character of an institution founded for the purpose of giving publicity to the most approved methods of husbandry at present known, and that of one designed to invent or discover improved systems, were more generally appreciated—it being not less wide than what exists between the person who lectures on the principles of a science, and one who strives to enlarge its existing boundaries—as distinct, in short, as are the merits of a Brande and a Davy; of a Hope and a Dalton.

The King of Bavaria has also founded a somewhat similar establishment to the one just described, at a short distance from Munich, and the domain appended to the royal palace of Schleissheim is given up for the purposes of a model farm, and as a place for providing instruction to young men in the principles and practice of husbandry. The scheme of education proposes to be modelled on the same general plan as that of Hohenheim, but when I visited it in 1840 the whole of the institution appeared to me on a much inferior scale. There were twenty-one scholars belonging to the upper, and eleven belonging to the lower class, but the latter are in fact not better than field-labourers; and even the former are expected to take a part in the labours of the farm, being, as I should conceive, nearly of the same grade as those of the lower department at Hohenheim. Accordingly the higher class pay only 150 florins a-year, (less than 15*l.* sterling), the lower not more than 60 florins (less than 6*l.*)

The land all about Schleissheim indicates its inferior productiveness in being chiefly covered by pine-forests, and the domain made over to the establishment is itself so notoriously

bad, that, it is said, the intention of Government in giving it up to the management of men of science was to put the utility of philosophical principles in agriculture to the severest possible test. The result, however, has not been such as to afford the conductors much reason to exult in any triumph gained over nature, and indeed it is obvious, that to found a model farm on land greatly below the ordinary standard of fertility, is equally a mistake, as it would be to devote to such a purpose soil of extraordinary natural productiveness. The one can hardly be improved, the other scarcely injured, by the method of culture adopted; and hence neither kind is calculated to elicit, or to display, the skill and science of those who conduct its management.

Owing to the barrenness of the soil, a twenty years' rotation is introduced at Schleissheim, in which wheat only occurs once; oats five times; barley and rye each once; whilst during six years out of the whole number the land is laid down in grass, and one year is suffered to lie entirely fallow.

Of the other establishments of the kind that are dispersed throughout Germany I have no personal knowledge, though I understand that schools of agriculture exist at Vienna, Prague, Pesth, and other places. So long ago as the year 1820, Dr. Bright visited one in Hungary, which had been set on foot by the patriotic Graf Festitts, on his estate at Keszthely. Dr. Bright, in his 'Travels,' states, that the school was divided into three departments, viz., simple agriculture, mathematics in connection with the same, and the necessary knowledge of physics as well as of the veterinary art: for each of these two professors are appointed, making in all six. The complete course of study was fixed at three years, during the course of which the students were subjected to an annual examination.

I am likewise but little acquainted with the agricultural establishments existing in Italy; although I paid a cursory visit in 1840 to one under the direction of Professor Comolli, near Pavia, and have heard great praises of that which the Marquis Rodolphi superintends in the neighbourhood of Florence.

On the Agricultural Establishments of Ireland.

Passing over these, let us come a little nearer home, and consider the institutions which have of late sprung up within the sister kingdom of Ireland, where the great body of landed proprietors seem to have their eyes opened to the importance, not only of model farms, but likewise of schools for the education of those who are designed for husbandry. I have been favoured with letters from the Secretary of the Royal Agricultural Improvement Society at Dublin, and from the Manager of the

Model Farm connected with the Office of Education in the same city, from which I collect the following particulars.

The former institution is engaged, 1st, in encouraging the foundation of local or district agricultural societies in different parts of the country, and in affording assistance towards the prosecution of their respective objects; 2ndly, in establishing an agricultural museum in Dublin for the reception of implements of husbandry, seeds, grasses, &c.; 3rdly, in the circulation of practical information connected with husbandry through the medium of cheap publications; and lastly, in the organization of an agricultural college for the education and instruction of the farming classes. This last design, the most important perhaps of any, has not, I fear, yet been realised; but I am happy to find, from a letter I have been favoured with from Mr. Skelling, through the kind intervention of Professor MacGauley, of Dublin, that the model farm alluded to as connected with the Education Board, is under the management of an agriculturist, who undertakes to communicate to the pupils sent there by the said Board instruction on rural economy, both of a scientific and practical description.

The primary object of this Board being to train up in the rudiments of the most useful kinds of knowledge those who are hereafter to be employed as teachers in the national schools of the country, in order that by these means the same may hereafter be disseminated through the community, it is thought highly important, that the attention of such persons should be specially directed to agricultural chemistry, as well as to other studies whereby their minds may become better informed on matters of rural economy. They accordingly are made to attend the lectures on chemistry, delivered by Professor MacGauley at Dublin, and are likewise enjoined to resort, during a portion of the time devoted to their education, to the model-farm at Glassneven, where they are lodged, and where during five mornings of the week they attend lectures on the leading principles of agriculture, and undergo an examination relating to the subjects there taught, whilst on the sixth they are taken over the farm, and have all the practical operations in progress shown and explained to them.

A certain number of in-door pupils are also admitted by the Board for the term at least of two years, who belong to the lower class, and pay 10*l.* a-year for board, lodging, and education. They work on the farm, attend the lectures, and receive every kind of instruction necessary to qualify them for land-stewards and managers of farming establishments. There is likewise a class of schoolmasters trained to conduct agricultural schools in different parts of the country. I am also assured that there has of late been manifested a great desire on the part of gentlemen

and opulent farmers to have their sons received as pupils, and that in consequence a question of great importance to the general interests of the country has been brought under the consideration of the Commissioners, namely, whether it might not be feasible so to extend the institution, as that persons of a higher grade in society should be admissible on paying a fair rate for their board and lodging.

On the Plans which have been set on foot with a view to the Advancement of Agricultural Science in England.

I am sorry to have nothing to report of a similar description with reference to our own country; for when we consider the rapid augmentation of our population, and the progressively increasing proportion of those who, though dependent for their support, like the rest, on the produce of the soil of Great Britain, are engaged in other occupations than those of husbandry, there would appear to be no portion of the globe wherein an equal necessity exists for putting into requisition all the resources of science, in order that the agriculture of the country may keep pace with the demands made upon it to supply the wants of the community.

Some patriotic individuals, indeed—as, for instance, the Earl of Ducie, in Gloucestershire—have founded what are called model-farms, with the view of pointing out to the neighbouring agriculturists the most approved methods of culture at present recognised.* Individuals also, who have acquired a reputation in farming, or who reside in parts of the country where husbandry is supposed to be best understood, often receive into their houses, as pupils, young men to be brought up to agriculture. These expedients, however, though useful so far as they go, must be admitted to serve but as imperfect substitutes for that combination of scientific with practical instruction which the government institutions on the Continent have been shown to supply.

The same reasons which prevent the director of the establishment at Grignon or at Hohenheim from undertaking doubtful experiments, will operate even more forcibly on the agent entrusted with the charge of a model farm by an individual proprietor; and the most intelligent steward or bailiff, who may undertake to instruct young men in the practice of farming, must of necessity be deficient both in the leisure and information necessary for imparting that amount of scientific knowledge which is communicated by the professors attached to the foreign institutions alluded to.

* See Mr. Morton's work on Soils for a statement of the plan pursued, and of the success with which it has been attended.

I must not, however, forget to notice the various schemes of agricultural improvement, of which that active-minded lady, the widow of my lamented friend, the late distinguished President of the Royal Society, Mr. Davies Gilbert, is now making trial on her estates at Eastbourne, in Sussex, and by which she states that the number of paupers in the workhouse had been reduced from 220 in July, 1840, to 130 in July, 1841; for although there may be some parts of her practice from which we may dissent, and others which are open as yet to reasonable doubt, yet few persons, I am convinced, would fail to reap instruction, and derive materials for thought and speculation, from an inspection of the changes which she has been instrumental in bringing about.

I will first state very briefly the principal peculiarities of her system, and afterwards offer my opinion respecting those points in it, on the merits of which I feel myself in any degree competent to pronounce.

First, then, I may allude to the village-schools she has been the means of instituting, which proceed on the principle of compensating the master for his trouble in instructing the boys committed to his charge by the profits he derives from their labour. The only remuneration in cash which the master receives is 1*d.* a-week from each boy—the same amount which is paid at the national schools: but the time of the scholars is divided into two equal portions, during one of which they are employed in cultivating his land, whilst during the other he devotes his time to their instruction. So far as the scholars are concerned, it would appear that a sufficient number of hours is allotted to impart to them an adequate knowledge of reading, writing, and arithmetic; and that the arrangement proved a profitable one to the schoolmasters was evinced by the thriving appearance of the little farms attached to their cottages, each of which was cultivated by the joint labour of himself and his pupils.

The Willingdon schoolmaster, in January, 1842, writes as follows:—

“I have nineteen scholars, to whom I teach reading, writing, and accounts, the church catechism, collects, and psalmody, on the national plan, without any salary, for 1*d.* per week from each boy, from nine to twelve o’clock; and, from two till five in the afternoon, cultivating the land. I have not lost one from dissatisfaction, but am glad to say they willingly assist me: and the Rev. Julius Nouaille, who recommended me, has applied to me for a master, to take a school at Pevensy of the same kind, for which he has obtained the bishop’s and the vicar’s consent; and a great farmer has willingly agreed to give up four acres of land for it.

“I am satisfied that I can keep two cows on the same quantity of land, stall-fed, where I could keep but one if allowed to graze. I have no grass-land, and all last winter my cows had only straw, turnips, and

mangel-wurzel, till green food came on in the spring. My hay is the clover I sowed with the grain crop last year. I have experienced a great deal of good from the liquid manure from the two tanks, one from the cows, and one from the pigs.

"The quantity of land I rent is five acres, on the side of the South Downs, at 3*l.* per acre, and 10*l.* for the house, making in the whole 25*l.* per annum. I might have taken off my crops, and lived rent free at Michaelmas; but I preferred staying and teaching, though I have no salary, and so I think would many others.

(Signed)

"GEORGE CRUTTENDEN."

The letter just read enumerates some other of her projected improvements, respecting which I am about to speak more in detail. Thus I may mention, in the second place, the system of allotments adopted by her; from which, though the primary object is to better the condition of the poor themselves, yet hints may be gleaned with respect to the general improvement of agriculture. The land is let out in parcels, varying in general from $\frac{1}{4}$ to $\frac{1}{2}$ an acre each—in some cases, however, amounting to 3 acres for one individual—and though the general condition of the occupants is greatly improved, and the poor-rates proportionately reduced, yet the rent paid is more than double that which a farmer on a large scale would be willing to offer. Thus, for land of the same quality as that which commonly lets for 18*s.* per acre, Mrs. Gilbert obtains, when it is parcelled out into allotments, not less than 40*s.* But the means by which this ability to pay an increased rent is represented as having been brought about, constitutes the third, and perhaps the most interesting, part of the system she inculcates. These are, first, the entire prohibition of the plough, and the substitution of spade-husbandry; secondly, stall-feeding, both of the cows and cattle, by which the dung retains all its virtue, instead of being dissipated by being scattered irregularly over the land; thirdly, the saving of the expense of horses and of human labour, by making the cows, and even heifers of less than a year old, belonging to the little tenants, work in harness, as is practised in some parts of Germany; fourthly, and lastly, the studious care taken to preserve every particle of animal manure of all descriptions that can be obtained on the premises, collecting the liquid portion in tanks made contiguous to the house, and mixing up the solid portions with earthy and other matters calculated to prevent the escape of their volatile ingredients.

Another improvement adopted by Mrs. Gilbert deserves a short mention, although it has in view rather the health of the peasantry than the direct improvement of the agriculture of the country. It appears that the low land about Eastbourne, lying upon the chalk marl, is subject to damp; whereas the higher

ground, which is situated on the chalk itself, is dry, and eminently salubrious. But as no wells could be obtained on the latter without great expense in boring, the cottages were all built on the low ground, for the convenience of water. Mrs. Gilbert, however, has obviated this necessity, by constructing water-tanks in the chalk itself, rendered impermeable by plastering the sides with mortar made of the grey lime, the lowest stratum of chalk that occurs near the spot; so that these serve as recipients for the rain which falls upon the roofs of the buildings. The amount of this is found considerable enough to furnish a supply of wholesome water sufficient for a family throughout the year; and, in consequence, has enabled her to remove the cottages of many of her peasantry to the slopes of the hills above, where they breathe a better atmosphere, and at the same time reside contiguous to their respective farms.

In one of her letters to me, Mrs. Gilbert states that she has, in the course of the summer, constructed six water-tanks, generally 12 feet deep and 8 feet in diameter; rendered water-tight with the grey lime, as it is called, found in the neighbourhood.

I may add, that the water from one of these, which I tasted in the month of September, though not so brisk and sparkling as well-water, was clear, and not unpalatable.

I will allude to one other plan adopted by Mrs. Gilbert, though aware that it will be considered by many of those who hear me rather as an expedient calculated to meet a temporary evil, than as a proceeding worthy of imitation under circumstances in general. During the period of agricultural depression which prevailed in 1831, this lady, at the suggestion of the present Archbishop of Dublin, found employment for her labourers, by causing them to transport four inches of soil from the surface of a rich alluvial clay land adjoining, to a bed of barren shingle lying near the sea-coast, which, from the nature of its composition, was absolutely unproductive—an equal quantity of the shingle being at the same time transferred to the marsh: and the whole labour was performed either on men's backs or in hand-carts drawn by men. After this was completed, the shingle let for 40s. per acre, and the rent upon it has been paid for five or six years past.

Many, however, may be disposed to think that the expense of this preliminary labour would, in the majority of cases, swallow up all the profits; and although it is stated that the land from whence the alluvial soil was extracted continues to pay the same rent as before, yet it may be anticipated that a time will come, when the loss it has sustained will require to be replaced by the addition of manure or by other expedients, and thus that the vulgar proverb of robbing Peter to pay Paul may be applicable to this part of her system.

Dismissing then from our consideration the above, as an example, perhaps likely in ordinary cases to mislead rather than to instruct, I will briefly point out, what I consider to be the merits, and what the defects, of those other arrangements which I have explained.

Now, in the first place, without entering into the general question as to the comparative advantages and disadvantages of *large* as contrasted with *small* farms, a subject which I may perhaps discuss on a future occasion, certain circumstances may, I conceive, be hinted at, which will assist in explaining the apparent success which Mrs. Gilbert attributes to her plan of allotments, without affording countenance to the introduction of the Irish cottier system into British husbandry.

Where the quantities of land let out to a cottager are no more than what he and his family can cultivate in their leisure hours, without depriving the farmer of any portion of those services for which he has contracted, it is plain that whatever produce has been reared upon his private ground must be so much clear gain to the nation, and contribute at once to the comforts and to the independence of the labourer. It is also generally admitted that spade-husbandry yields of all others the greatest return : and even conceding, what some respectable authorities are disposed to question, and which the success of the Belgian practice of farming may seem to controvert, that the additional produce gained will not compensate for the increased outlay ; and that the plough is to the spade in husbandry what machinery is to manual labour in the arts, enabling us to complete the same work, if not so well, at least in a far shorter time ;—admitting all this, I say, still, in those small plots of ground, to which alone the poor man is competent to attend, there are many circumstances which render the plough less applicable than it would be on a farm of larger extent. That for such small portions of land the cottager can afford to pay a higher rent in proportion, than the farmer can do for a larger tract, is consistent, I believe, with general experience, and perhaps admits of explanation from the following considerations.

The most important, perhaps, of these is the care with which every portion of animal manure produced upon the premises is taken advantage of. I have already mentioned the tanks for containing the liquid portion attached to each cottage, and likewise the means by which the solid matters of all descriptions that can contribute to the same result are treasured up and preserved. Here at least the exertions of Mrs. Gilbert have been productive of unmixed good ; and it is easy to understand, that these excrementitious matters may be at once more abundant in proportion to the extent of land to which they are added, and may be

preserved with greater care by a cottager, than is usual, or perhaps practicable, on an extensive farming establishment. The cottager also, being unable to resort to any artificial substitutes, feels more immediately and more palpably the loss sustained by his crops, from any waste of the limited quantity of animal manure he is able to provide, and is therefore more strongly and more frequently admonished of the utility of preserving all he has, unimpaired both as to quantity and quality.

The practice too of feeding the cattle in stalls, or in a yard where their dung can accumulate in the mass, and therefore does not waste as it would do were it scattered over the field, is a practice equally economical, whether adopted on a large or on a small establishment.

But with regard to the system of letting land in portions too considerable to be kept in order by the labourer after his hours of work are over, and yet small enough to require the care of only a single family, I think that reasons may be assigned for its succeeding at Eastbourne, although, generally speaking, it prove disadvantageous. In the first place, the greater number of those persons who find it answer their purpose to rent three or four acres of ground at the same high rate which others pay for smaller plots attended to during their hours of leisure, combine with farming occupations the office of village schoolmaster, and are thus, as I have already explained, indemnified by the gratuitous labour of their scholars. Now, if the tenant has no more land than he can well look after, and if he be able to exert sufficient influence over his boys to secure the full benefit of their exertions during their hours of manual labour, it is conceivable, that he may be able to cultivate his ground at a smaller expense than the large farmer can do with hired labourers. Moreover, as a man capable of directing to advantage the labours of nineteen or twenty lads must possess some intelligence, it may readily happen that he will communicate the same elementary instruction in a shorter space of time than is effected by a village schoolmaster of the ordinary stamp.

When, therefore, the proceedings of the master are sufficiently overlooked to guard against the indulgence of the temptation which would naturally beset him, of evading that part of his duties which is designed for the benefit of his pupils, seminaries founded on such a principle may prove eminently useful; and in America, especially among the New England States, I heard of several of a superior description, in which a similar system was resorted to. It must, however, be confessed that a school of this kind, if not properly watched, might, in the hands of an unscrupulous master, be more likely than those on the common plan to lead to abuses, of which those of Dotheboys Hall, immortalised in 'Nickleby,' would furnish in some respects no unapt representation.

Suggestions for the Improvement of British Agriculture.

It may be gathered then, from all which has been above stated, that the only measures for improving agriculture, as yet resorted to in this country, are of a private nature, and that even these aim chiefly at affording examples of the most approved methods of farming already in use amongst us, so as, if possible, to bring the whole agricultural body up to the same point, which has been attained by those of their number who are the most forward in the race of improvement.

Of the utility of such attempts none can pretend to doubt, for what friend to his country would fail to rejoice, were he to see the system of husbandry throughout Great Britain as well conducted as it is in Norfolk or in the Lothians? But it does not therefore follow that we are to rest satisfied with our present progress, or fancy that the productiveness of the soil has attained its utmost limit, even in the hands of the most successful cultivators of the present day.

Agricultural chemistry, we must recollect, is still only in its infancy, and the serious intention of applying the information it affords to the practical business of a farm is, as it were, only a thought of yesterday, and, even now, does not meet with general recognition amongst the great body of cultivators.

To find means, therefore, for advancing the science of husbandry, is at the least as important to the well-being of society, as to disseminate the stock of knowledge at present confined to a few; and for effecting the former object two measures seem to me to be called for—the first, the establishment of seminaries designed to impart to youths bred up to farming theoretical as well as practical knowledge adapted to their future calling—the other, the creation of experimental farms, on which might be carried on, under the direction of competent persons, some of those researches, which seem calculated to elucidate the principles, as well as to improve the practice of husbandry.

On the former subject I have already said enough, when decanting on those public establishments on the Continent which have been instituted with that express object,—but on the latter I will venture on a few remarks, in order to explain more clearly what I hold to be their real scope and bearing, and thus to remove some objections which I have often heard alleged against their foundation.

Many, for instance, are of opinion, that for a government or a society to support an experimental farm would be an idle waste of money, because individuals in the present day will always be found ready to undertake at their own cost any sort of researches on agriculture that may appear to hold out the slightest probability of advantage. And as these individuals, if numerous, will na-

turally hold land possessing every conceivable quality, and placed in every variety of local and geological position, the experiments undertaken by them will, it is said, be varied in a much greater number of ways, and thus be more likely to instruct us, than those which might be conducted within the narrow precincts of one or more experimental farms.

Now those who reason in this manner appear to me not sufficiently to appreciate the distinction existing between the empirical and the scientific method of acquiring knowledge, or, if they do, have not altogether divested themselves of the notion so deeply rooted in the minds of agriculturists in general, that by empirical methods alone husbandry is to be advanced.

To show the superiority which the scientific method of arriving at truth possesses over the empirical, we will suppose what would happen were any new chemical compound to be offered to the attention of agriculturists. No sooner had such a substance become known, than, judging by past experience, it may be predicted that its employment would be found advantageous on some soils, and useless or injurious on others, and thus an attempt to define what the descriptions of land might be which it particularly favoured, would follow almost immediately upon its first application. Undoubtedly, such an inquiry may be carried on without much apparent difficulty in the usual empirical method, namely, by engaging a sufficient number of gentlemen resident in different parts of the kingdom to try the effects of the manure upon their own land, and to report the results to some person commissioned to give them publicity.

But it is surprising how many tentative efforts must be gone through, before a knowledge can be arrived at of the real circumstances by which its failure or success in any given case is determined. Of the experimenters, the majority present us only with such a general description of the land on which the manure was used, as is included under the terms of clayey, loamy, sandy, or marly, in common use, to the vagueness of which I have already adverted. Others, ambitious of greater precision, have perhaps sent a few hundred grains of the soil to some chemist for analysis, and in consequence may be able to report faithfully the proportion of clay, silex, calcareous earth, &c., present—still, however, leaving us in the dark as to the existence or non-existence of those minute quantities of alkaline and saline matters, on which perhaps the suitableness of the manure in question mainly depends. Hence, without any fault on the part of the analyst, who cannot be expected to detect such minute quantities in the small amount of soil usually submitted to him for examination, it is very possible that two samples which he reports to be chemically the same may be benefited in a very different degree by the foreign matter

superadded. Again, the state of the weather, in itself a very complicated problem, often materially affects the result, and the accounts given of its condition, by those who think it worth noticing at all, are seldom so precise or so comprehensive as to embrace all the elements on which its influence depends.

Thus, after all, the information we obtain by the empirical method may fail even in its narrowest application, namely, that of enabling us to discriminate the *kind* of land, or the *description* of crop, which a particular manure appears to favour, and still less able is it to afford us a clue to the discovery of fit substitutes for it, when the material itself is unattainable.

How superior to this, even in point of practical utility, is the scientific mode of proceeding, which sets out with investigating the precise manner in which a particular manure acts upon the soil and crop! If, indeed, it appear at first sight more difficult to attain in this way the end proposed, we are rewarded at least in the long run, by acquiring a knowledge applicable—not merely to the individual case for which it is sought—that is, to a given crop, on a given soil, belonging to a given country, and under circumstances of climate in all respects analogous—but likewise to all future times, and to every other kind of soil of which the chemical constitution has been duly ascertained.

Let us, by way of illustration, take the case of nitrate of soda, respecting the utility of which the empirical method of research has as yet presented us only with the most conflicting evidence. Let us suppose it to have been placed beyond the reach of doubt, by a series of carefully conducted experiments, that this salt operates beneficially, not by communicating a direct stimulus to vegetation, but by supplying nitrogen and soda, ingredients which many crops require for their food. Let us also suppose it to have been ascertained, by another series of experiments, that the nitric acid of the salt supplies nitrogen only by becoming previously the instrument of generating ammonia, and that for this to take place the influence of a certain intensity of solar light is indispensable. Irrelevant as such speculative truths as the above may appear to the every-day operations of farming, it will not be difficult to show, that they are calculated to fulfil more important practical ends, than experiments designed to ascertain by direct means the increase of produce arising from the application of the said manure to a particular field.

Once furnished with these particulars, we may infer, for example, that the salt in question is only appropriate for soils in which nitrogen is deficient, or, in other words, where ammonia is neither supplied sufficiently from the materials of the land itself, nor from the animal matters superadded. So also a knowledge of the atmospheric conditions necessary to bring about its de-

composition will enable us to trace to its true origin any failure that may have occurred in its use on land previously benefited by its application, and to discriminate between the above source of disappointment, and another which will probably be found connected with a deficiency in some other material which the plant requires for its nutrition, and which the salt is not calculated to supply. This kind of knowledge will moreover enable us to predict, not only the kind of soil and the description of crop which the salt will be found to favour, but likewise what other substances are likely to furnish a substitute for it when it chances to be wanting. Thus it may be confidently predicted, that if the operation of nitrate of soda be such as has been represented, certain compounds of ammonia might to a certain degree serve in its place, and produce those effects upon the crop which have been traced to the evolution of nitrogen from the salt in question.

I am far indeed from meaning to contend that scientific investigations ought to supersede the use of other more empirical methods of advancing agriculture; for all general scientific conclusions perhaps are subject to some degree of uncertainty, and, owing to the imperfection of all our knowledge, even the best established truths are liable to mislead, when we attempt to deduce practical inferences from them. No sooner, indeed, have we crossed the threshold of the temple of Truth, than the mists that obscure our path render every fresh step we take in advance more difficult, and may prevent us from steering our course aright, even though assisted by the light which emanates from the sacred precincts.

But still I cannot but contend, that in conjunction with, or rather perhaps as preliminary to, those empirical trials which practical men are willing to undertake respecting a given manure, it would be highly useful, if a course of experiments were set on foot to determine the exact mode in which it operates upon the soil and upon the crop. And I know not how such experiments can well be instituted, except it be on an experimental farm, established for the purpose, and placed under scientific hands. Productive of no immediate advantage to the land on which they are tried, beyond what could be equally well attained by a much inferior expenditure of labour, they are not likely to be taken up by any private individual, who combines practical experience and pecuniary resources with the requisite scientific skill; and even if such a person were to present himself, what guarantee can we offer to the world that he possesses the requisite qualifications?

I therefore fear that such trains of research as I have alluded to will never be conducted in a manner calculated to command the confidence of the public, until an experimental farm be set up for the purpose; and when so wide and important a superstructure is to be raised upon the principles we aim at establishing, it is

proportionately of greater moment that the foundations themselves should be secure.

So great, indeed, appear to be the advantages, when balanced against the expense of such a scheme, at least on the small scale on which I should propose to have the experiments conducted, that one might look forward with sanguine hope to the speedy establishment of one or more farms of this description, if the gentry who interest themselves in agricultural matters were only well informed on those branches of physical science which bear a near relation to the successful culture of the soil.

But, unfortunately, we must, I fear, regard this description of men, as a body, but little disposed, considering their means and opportunities, for the cultivation of physical science, even to that limited extent indeed which would lead them to take advantage of the appliances so largely afforded by our Universities for the acquisition of this as well as of every other kind of knowledge.

It is rare, if I may judge by my own observation, to discover, even in those amongst their number who have completed their academical career with the highest distinction, that mere smattering of the physical sciences which would be sufficient for enabling them to appreciate the agricultural importance of such knowledge. And until this defect be remedied, either by the spontaneous efforts of the University itself, or through the loud expression of public opinion from without, it were vain perhaps to expect, that agriculture can receive the development of which it is susceptible, or that those means will be resorted to by which its true principles might be properly investigated.

I therefore cordially concur in the sentiments which have been already expressed in other quarters on this subject, and in conceiving, that the want of a special education for the agricultural classes of all ranks and conditions constitutes one of the principal checks that exist at present to the due advancement of this country's agriculture; and that the best friends to the interests of this important branch of the community, are those who strive to disseminate as widely as possible amongst them a knowledge of the theory as well as of the practice of the art; whether it be, by rendering our village-schools the vehicle of some instruction of this kind to the labouring poor; by establishing seminaries and colleges of a higher grade to impart the requisite knowledge amongst the farmers; or, lastly, by introducing such provisions in the system pursued at our Universities, as may induce her future landlords and legislators to avail themselves of those means of instruction in the physical sciences, which the bounty of a long train of benefactors has placed within the reach of every Student during his residence within the walls of our Colleges.

XXVIII.—*On the Dyock Oat.* By the Rev. R. W. FISHER.

A REPORT of a series of trials of a new variety of oat, called the Dyock oat, by Mr. John Watson, of Ledmore, near Brechin, having appeared in the 'Transactions of the Highland and Agricultural Society of Scotland,' in Sept. 1840, and the results being highly favourable, and possessing peculiar claims to the attention of those occupying lands of considerable elevation, I was induced to make application for a small quantity of seed. In the spring of last year I received from him half a quarter, and he kindly added many valuable suggestions for my guidance in making the experiment.

So far as the return of one year, and the appearance of my crops the present season, can be considered as bearing testimony to the value and probable utility of this variety of oat, I am enabled to confirm the favourable opinion expressed by Mr. Watson: and it is with a view of introducing it to more general notice that I wish briefly to communicate a few details of the experiment. I would first premise that the land on which I sowed the half-quarter is a poor red soil, resting upon a clayey subsoil, at an elevation of from 400 to 500 feet above the level of the sea, and was enclosed from a common about twenty years ago. A poor crop of turnips had been grown upon it the year preceding, with 20 bushels of bones to the acre, one half of which was drawn, and the other eaten off with sheep. The alleged qualities of the oat in question, which induced me to make trial of it, were early maturity and an abundant return. As a test of the former, I selected the potato-oat to sow with it in the same field, upon land of precisely the same texture and quality. The early part of the season of 1841 was remarkably fine here, and the potato-oats were sown on the 18th of March, the ground being friable and in beautiful order. On the following morning the Dyock oats were sown; rain having interrupted the sowing on the preceding afternoon, which, continuing during great part of the night of the 18th, rendered the state of the soil not so favourable for harrowing in the seed. In both instances the seed was sown broadcast, at the rate of 5 bushels to the acre. The crop was better than I anticipated from the state of the field, growing rather vigorously, but with a perceptible advantage, as regards forwardness, in favour of the new variety; though, when reaped, the straw of the potato-oats was, I think, a little longer. These were reaped on the 20th of September; the Dyock oats having been cut on the 31st of August. The returns were, from the potato-oats $6\frac{9}{10}$ times the seed; from the Dyock oats $8\frac{3}{4}$ times. The former weighed $36\frac{3}{5}$ lbs. per bushel, and yielded of oatmeal $17\frac{3}{10}$ lbs. per bushel;

the latter weighed 40 lbs.* per bushel, and yielded of oatmeal 21½ lbs. per bushel. The straw is of excellent quality, well adapted for fodder. This oat takes its name from a Mr. Dyock, who, I believe, first raised the variety in Aberdeenshire. If, after a further test, its good properties be maintained, there is little doubt of its proving a highly valuable acquisition, especially upon the cold and elevated lands of the northern part of the kingdom. Mr. Watson, from whom I had my seed, has tried it for several years, and speaks of more abundant returns, and of heavier grain, than I have detailed above. He states that it usually arrives at maturity from 12 to 16 days before potato-oats; and, I believe, the higher the elevation, the greater is the difference in this respect. It is rather small in the grain, but is distinguished from several other early varieties of the oat by the thinness of its husk. I would refer those who are anxious for further information to the 50th No. of the ‘Quarterly Journal of Agriculture,’ in which appears Mr. Watson’s paper on this oat; to whom the merit is due of bringing it into more prominent notice, and of directing the attention of cultivators to its valuable properties.

Hill Top, Kendal. July 4, 1842.

NOTE.

This oat may be so valuable for elevated moorland districts that all the information we possess respecting it ought to be laid before the Society. The following account appeared in the ‘Transactions of the Highland Society,’† two years ago.—PH. PUSEY.

“My attention was first directed to this oat in the year 1833, from seeing a neighbour farmer have a small patch sown with it, which appeared strong, and considerably earlier than the other kinds of oats sown in the neighbourhood. On inquiry of the owner I learned that he had increased the kind from a few grains, not exceeding half an ounce in weight. The original raiser was a Mr. Dyock, or Diock, near Aberdeen, who began with a single ear picked from a field, and, by preserving and cultivating it, soon obtained a quantity, which was distributed among the farmers in Aberdeen—

* With regard to the weight of this, it is understated. The potato-oats were sent to the mill, where they were weighed immediately upon being measured into sacks; whilst the Dyock oats remained in the sack, after being measured, more than three months before they were sent to the mill and weighed, the mouth of the sack being open the whole of the time, and the grain consequently exposed to mice and to loss in moving the sacks, &c. Unfortunately, I did not see it before it was sent; but, upon questioning the miller, he says the quantity was much below the alleged measure; and, according to his estimate, the grain would weigh 45 lbs. per bushel. I am inclined to think this is about the truth; as my farm-servants, who were much prejudiced against “*the Scotch corn*,” admitted its marked superiority of weight over the potato-oats, when they placed the sacks in the granary. As, however, I am fearful of advancing any fact in a case like this which cannot be verified, I have retained the lighter weight, though satisfied of its inaccuracy.

† Quarterly Journal of Agriculture, No. L., p. 372.

shire, for field-culture. Whether any adverse circumstances in time of rearing had deteriorated the quality I am not enabled to state; but, so far as is known to me, the quality of the corn was neither so good, nor the returns so abundant, as both have been since this oat came through the hands of my neighbour Mr. Davidson. Last year I saw samples from Mr. Dyock's original stock in Banffshire, but they appeared coarse and husky; and I am not aware if the kind is there considered worthy of cultivation. The half-ounce with which Mr. Davidson commenced was first sown in 1830, and, by great care and attention in nursing this small quantity, he was enabled, by 1834, to dispose of small quantities for seed. I received a quarter in the spring of 1835, which I sowed, and was so well pleased with the return, that I have continued to cultivate the kind every succeeding season with success. Mr. Davidson had raised twelve and fourteen returns from his seed annually; his land being a good black loam, and at a lower elevation than mine. I resolved on trying the oat on one of my highest lying fields, where the soil was neither deep nor rich. To shorten details, I have condensed the result of my experiments in cultivating Dyock's improved early oat into a tabular form. The produce may not be thought great by persons accustomed to crops on superior land; but those who farm late high-lying soils may hold a different opinion.

Date of Sowing.	Quantity Sown.	Extent of Ground.	Description of Soil.	Date of Reaping.	Produce.	Wt. per Bush.
	Qrs. Bus.	Imp. Ac.			Qrs. Bus.	lbs.
1835, Mar. 29	1 0	—	Grey loam, dry bottom .	Sept. 9	8 3	43½
1836, Mar. 28	4 0	—	Black loam, stiff clay bottom	— 16	18 1	43
— Apr. 28	0 5	—	Red, poor clay, wetish .	Oct. 3	2 0	—
1837, Apr. 8	1 2	—	Heavy soil on clay . .	Sept. 14	7 1	42½
— — 17	4 6	—	Thin free soil, till bottom	— 18	28 4	41
1838, Apr. 5	4 3	5375	Good, free, black loam .	— 14	44 0	42½
— — 20	3 1	4410	Mixed, clayey, and late .	Oct. 10	15 4	41¾

Results, as compared with Potato, Flemish, and Kildrumny Oats, sown on the same Fields at the same Dates.

DYOCK'S OAT.				POTATO OAT.		
Year.	Returns.	lbs. per Bushel.	Meal, per 6 Bush.	Returns.	Weight per Bushel.	Later in Ripening.
1835	8 $\frac{3}{4}$	43 $\frac{1}{2}$	148 $\frac{3}{4}$ lb.	7	42 $\frac{1}{2}$ lb.	11 days
1836	4 $\frac{1}{2}$	43		3	39 —	17 —
1837	6 $\frac{3}{4}$	42 $\frac{1}{2}$		5 $\frac{1}{2}$	40 $\frac{1}{2}$ —	14 —
KILDRUMMY OAT.						
1837	5 $\frac{7}{10}$	41	135 $\frac{1}{2}$ —	5	40 lb.	29 days
POTATO AND FLEMISH OATS.						
1838	10 $\frac{1}{6}$	42 $\frac{1}{4}$	143 —	8 $\frac{1}{3}$	42 $\frac{1}{2}$ lb.	12 days

“ In this season (1839) I sowed Dyock's oats in parts of four fields; but I have only got the return of grain from one piece of 2 acres. The produce is 6 quarters per acre, and weighs 40 lbs. per bushel. The grain was stained by rain when in stooks, and, though not so fine as I have formerly grown, will yet bear comparison with any other kind of oats grown in this neighbourhood this season. Last year, for comparative trial, I sowed, on a

field of late land, potato, Flemish, Friesland, and Dyock's oats; but the October storm blasted all excepting the latter, which were reaped. The concurring opinion of all farmers who have sown this oat is, that its straw makes fully as good fodder as the straw of the potato-oat; cattle eat it well, and thrive on it. The average altitude of the farm on which the foregoing trials were made is about 400 feet above the level of the sea, and lies inland. The soil is partly a black loam, incumbent on rock or stiff clay, and partly thin soil of grey or faint-brown colour on a till bottom. I have generally, though not invariably, sown Dyock's oats on land broken up from lea, in the usual broad-cast manner by hand, at the rate of nearly 6 bushels to the acre, and harrowed in the seed in the ordinary way. The kind of land most adapted to its growth I conceive to be a soft friable soil. Whether deep or shallow, my experiments on clay were the least successful; neither do I think it fit for a hot, sandy soil. It grows fast, requires to be thick sown, and cut before appearing fully ripened. The straw grows as long as any of the other kinds of oats grown beside it. The average length I have grown it would be from 3 feet 4 inches to 3 feet 9 inches; but, in 1838 and 1839, some of it was $4\frac{1}{2}$ feet and upwards. The weather this harvest has been so unpropitious that fair trials of the grain could scarcely be made by thrashing a small quantity. Part of these crops was cut on the 9th of September, at which date no other oats were matured in the neighbourhood. The yield of meal, where trials have been made of this year's crop, has been greater from Dyock's oat than from any other kind which has come under the writer's notice. The most valuable characteristic of this oat is its early maturation, being about fourteen days earlier than potato-oats in all late soils. It is, therefore, well adapted for lands which have a tendency to lateness; and will, I trust, under proper management, prove of great benefit to the high-lying and late districts of Scotland. Since 1836 the merits of this oat have been fairly tested. It has been tried in ten parishes in the county of Forfar, in several of which the crops are usually late, and it has always come to maturity from twelve to sixteen days before potato-oats. In the upper parts of the parishes of Tannadice, Cortachy, and Lintrathen, it has been cultivated with success during the three last years, which it is well known have been more than usually late. In proof of its earliness, and consequent adaptation of the grain for late farms, I can appeal to the testimony of respectable gentlemen who have got seed-corn from my farm for their late lands. David Craik, Esq., of Auchnacree, got 9 quarters of the improved Dyock oat last year: the crop was all cut before the 11th of October; his other oat-crops on Auchnacree were uncut, and consequently were blasted by the hurricane which then happened. David Black, Esq., Broomfield, has got it for Glenogil for several years back. Mr. Stewart Wyllie, Kinrue, by Cortachy, got 2 quarters in the spring of 1838, which produced upwards of 12 quarters: no other oats on his farm were fit for seed that year. Mr. Francis Baillie, Dalgetty farm, near Brechin, got 2 quarters in 1838; his return was 19 quarters 5 bushels. Mr. Webster, Blackhall, Menmuir, has also been a successful cultivator of this oat, and has had abundant returns.* Mr. Fenton, Purgavie, also succeeded well with seed of this oat, which he obtained from this neighbourhood. I remark, in conclusion, that there is no other stock of this oat in this country than what was raised from the few grains already mentioned; and if this kind, which appears to me to be a variety either of the potato or Zealand oat, is found worthy the attention of agriculturists, the merit of fostering it is due to Mr. James Davidson."

* Since writing the above I have a certified return of 75 bushels per acre from a field of newly broken-up old lea this season.

XXIX.—*Report on the Wheats selected for Trial at Cambridge, and on other Wheats.* By W. MILES, M.P.

HAVING been appointed, with Messrs. Handley and Kimberley, to try the four wheats selected for prizes at Liverpool, and a wish having been expressed by some members of the Council that I should drill in several other approved sorts of wheat together with those selected, all subject to precisely similar conditions, in September last I chose for the experiment a one-year-old clover-ley on a sandy loam, gently sloping to the N.N.W. The crop of clover had been very good, nearly 50 cwt. an acre; from some part of the field I had taken a second crop, feeding the remainder with sheep and young beasts; no visible difference, however, was afterwards apparent in the grain crop, either in quantity or quality, from these distinct modes of treating the second crop of clover.

The field was ploughed on the 20th of September, and, having been laid out in half-acres for the ploughing-match of the Bath and West of England Society, was continued in the same state for the experiment, each half-acre being separated by 27 inches of grass-balk.

The sorts selected for trial were—of white wheats—

From Liverpool,	No. 1, Belle Vue Talavera.
From ditto,	No. 2, Chidham.
From Mr. Kimberley,	No. 3, Silver-drop.
From Mr. Jonas,	No. 4, a seedling—Jonas's Prolific.
From Lord Ducie,	No. 5, Sheriff's.
From Mr. Pusey,	No. 6, Golden Swan.

And of red wheats—

From Liverpool,	No. 1, Burwell.
From ditto,	No. 2, Red Champion.
From Lord Ducie,	No. 3, Britannia.
From Mr. Pusey,	No. 4, Mr. Fisher Hobbs's Red Marigold.
From Wilts,	No. 5, Old Red Lammas.

To each of these wheats 3 half-acres were allotted, except to Mr. Jonas's seedling, of which I had but sufficient seed for an acre: the quantity sown per acre was 2 bushels and 1 peck. On the 27th of September, previously to breaking up the clover, 10 bushels of $\frac{1}{2}$ -inch bones were sown broadcast over the field. On Tuesday the 12th of October, I commenced putting in No. 1 white with a Suffolk drill, and finished No. 5 red on the Friday following. On Tuesday the 26th No. 2 white appeared; on the following Saturday all the whites were up; on the 3rd of November the red wheats were partially, but without any apparent priority of germination, showing. The appearances of the white wheats were—No. 1, sixth; No. 2, first; No. 3, fourth; No. 4,

third; No. 5, fifth; No. 6, second. No. 1 came up very indifferently; indeed it seemed, from the incessant rains, which had continued almost without intermission from the time of sowing to this period, to have perished in the ground; and as this wheat never afterwards improved, but was entirely hoed in again in February, it may be considered as having totally failed with me. Last year, however, in which there were several very sharp frosts and a good deal of catching weather, I reaped a most capital crop of Belle Vue Talavera, nearly 5 quarters an acre, which had been sown in October, 1840. This wheat in our climate I consider essentially a spring wheat, and as such invaluable, for in the parts of the trial-field this year where the plant was very deficient, or had totally failed, I hoed it in from the 6th of February to the beginning of March, and the wheat so sown was ready for the sickle as early as those sown in October. On the 21st of November I found the appearances of the wheats thus noted:—Whites, No. 2, third; No. 3, fourth; No. 4, second; No. 5, fifth; No. 6, first: Reds, Nos. 1 and 2, first; No. 3, fourth; No. 4, second; No. 5, third. The first fortnight in January was very trying to the plant, as we had alternate sharp frosts and sudden thaws without snow. On the 22nd the wheats were going off terribly, and the wire-worm was general in its ravages: I immediately put the heaviest roller I could get on the field and rolled it till the surface was as hard as a turnpike-road; still the damage apparently done was immense, and a neighbouring farmer guessed that the product of the field would not be above 16 bushels per acre: the rolling, however, stopped the progress of the wire-worm. On the 5th of February I began hoeing in Belle Vue Talavera on those spots of the trial-pieces where the plant had nearly disappeared: of the whites the whole of No. 1 was put in afresh; of No. 5, about two-thirds of an acre: of the reds a little was put in in Nos. 1 and 2; nearly all in No. 3; and about half an acre in No. 5: so that of the white wheats Nos. 2, 3, 4, and 6, and of the reds, No. 4, were the only wheats which stood the winter for crop as first planted. On the 2nd of April I find that the wheats on the whole were very bad; but from the 25th of March until the 23rd of April, not sufficient rain fell at King's Weston to wet the ground, and at this period the wheats began to mend; their improvement being gradual, but extraordinary. I was absent from home during the blooming, but was informed by my farming-man that very little difference was perceptible between the flowering of the whites, and that the reds came into bloom from a week to ten days after the whites. On my return from London at the end of the first week in July, I found the general improvement still progressing; the tillering, considering the nature of the soil, had been extraordinary, and the ears were upright and full: I therefore carried out the

experiment as far as was practicable, selecting, as had been agreed upon at Liverpool, 16 perches from each variety, cutting it with the scythe, and accurately weighing the grain and straw. On the 2nd of August I marked out, as nearly as my eye could enable me to judge, 16 perches of average equal growth and occupying relatively similar positions in the field, from Nos. 2, 3, 4, 5, and 6 white; and from Nos. 1, 2, 4, and 5 red, similar quantities, but, excepting No. 4, not in relative situations to the white wheats; yet still, had the season been generally favourable, such 16 perches as I estimated would have been fair samples of the produce of these wheats. The white wheats, however, throughout appeared better suited to my land than the reds; and the result of the experiment has convinced me that, in soil and climate similar to that on and in which I have made the trial, the growth of the former should be encouraged rather than the latter. Before reaping, the appearance of the different wheats was as follows:—Whites, No. 2, third; No. 3, fourth; No. 4, first; No. 5, third; No. 6, second: Reds, No. 1, third; No. 2, second; No. 4, first; No. 5, fourth. For the reason before specified, viz. the almost total destruction of the plant of No. 3, no portion of that wheat was measured off for the experiment.

On Friday the 5th of August I cut with the scythe the whites, on the Monday the reds, and on the following Wednesday and Thursday carted the respective lots. The subjoined table will show you the results of the produce of wheat-straw and flour per acre of each kind, estimated from the product of 16 perches of each. I conceive, however, that, were the whole of the produce of each sort to be thrashed out, none of the crops would come up to this average; but the appearances of Nos. 4 and 6 white, and No. 4 red, were generally good, and the tabular results would not at most give 2 or 3 bushels per acre above their respective produce. Every attempt, however, as far as the season permitted, has been made to carry out the experiment with perfect fairness. I consider for the bulk of straw the yield of grain was extraordinary, and the samples of wheat of each kind can scarcely be surpassed, subjected as they were merely to the usual dressing. The miller declared that he had never ground better flour; but stated that, if he had any preference, he should give it to No. 2 white, and No. 1 red. In the process of converting the flour into bread, better than which I never have tasted, the plan recommended by Colonel Le Couteur in vol. i. p. 115 of the Journal, was adopted, viz. “18 lbs. of the flour of each sort was placed to rise or sponge over-night with $\frac{1}{2}$ a pint of yeast and 2 quarts of water. At nine o'clock the next morning 4 oz. of fine salt were added, together with as much water, milk warm, as each kind would imbibe to fit it for the oven, which was well worked up,

drawn up (as it were) into strings to expose it to the air as much as possible in order to render it light, left to rise for 20 minutes or $\frac{1}{2}$ an hour, baked and weighed next morning." The subjoined tabular statement will, I think, prove the necessity of carrying out all our experiments to the utmost, as otherwise great danger will arise of discarding valuable sorts, merely from their being in one or two instances less productive than others, which may be accounted for from the chances of the season, or other disturbing, but not sufficiently investigated, causes. Of the white breads No. 6 was the whitest, No. 4 the closest, and No. 2 the lightest; of the brown, or rather that made from the reds, No. 5 was the whitest and lightest: the others were much the same in colour and quality.

Numbers of Wheats.	Weight per Bushel.		Produce per Acre, estimated from 16 perches, cut, weighed, and thrashed by hand.			Weight of Straw per Acre, similarly estimated.	Weight of best Seconds Flour per Acre, estimated from 2 bushels of each.	Weight of Gurgeons and Bran, do. do.	Quantity of Water imbibed by each sort in working up.	Quantity of Bread from 18 lbs. of Flour, of each sort.
			Head.	Tail.						
	lbs.	oz.	Bush.	lbs.	lbs.	Tons. cwt. qrs. lb.	lbs.	lbs.	Qts. pints.	lbs. oz.
W. 2	62	11	32	60	44	1 8 0 24	1707	389	2 0 $\frac{1}{4}$	26 2
W. 3	63	0	32	0	40	1 0 0 0	1699	328	1 1 $\frac{1}{2}$	24 14
W. 4	62	8	43	24	40	1 7 0 11	2229	499	2 0 $\frac{1}{2}$	23 11
W. 5	62	5	34	22	53	1 8 3 10	1683	489	2 0	24 1
W. 6	63	11	32	7	43	1 7 0 24	1700	369	2 0 $\frac{1}{2}$	25 10
R. 1	64	0	28	39	62 $\frac{1}{2}$	1 3 2 23	1588	348	1 11 $\frac{1}{2}$	23 14
R. 2	62	5	38	17	60	1 7 2 20	1894	459	1 1 $\frac{1}{2}$	24 0
R. 4	62	5	32	25	30	1 4 1 14	1646	348	1 1 $\frac{1}{4}$	24 8
R. 5	62	11	31	42	44 $\frac{1}{2}$	1 4 0 12	1583	380	2 0	25 4

It will be perceived that No. 4 white was by far the most productive of the trial wheats, and as Mr. Jonas, when he presented this prolific seedling to me, sent me an account of its origin, I think I cannot do better than insert an extract from his letter, as it may encourage farmers, should they accidentally discover amongst their crops ears of corn of extraordinary productiveness, dissimilar to the bulk of the crop, and of apparently new habits, to preserve and cultivate such more generally than they do at present, for the purpose of raising valuable varieties. Mr. Jonas thus wrote in September, 1841:—"You will oblige me by accepting 3 bushels of white wheat, which I have raised from a single ear, and by growing it side by side with the trial-wheats of Liverpool. I have no fear of the result; but should the Liverpool selected wheats be more prolific and valuable than mine, I shall be highly gratified, as I should cease growing the sort I have

thus raised, and have some of that which was better. I would thank you not to sow this wheat before the latter part of October, or the beginning of November, as it is inclined to tiller early. I send you the exact quantities grown each year from this single ear, and I do so that you may avail yourself of any opportunity or way you please of showing to my brother-farmers how short a space of time is required to raise a good sort of any grain:—

Years.				Produce.
1838	dibbled in 50 kernels (30 of which only grew)			14 $\frac{3}{4}$ oz.
1839	“	“	14 $\frac{3}{4}$ oz.	“ 1 bush. 1 peck
1840	“	“	1 bush. 1 peck	45 bush.
1841	“	“	45 bush.	“ 537 bush.

And had this wheat not been as much red-gummed as my other sorts, I believe I should this year have had 100 bushels more.”

This concludes my report, and it will be for the Council to determine, after the receipt of the reports of Messrs. Handley and Kimberley, whether or no they think the wheats selected at Liverpool for the prizes are so superior to the sorts in general use as to entitle them to the stamp of approbation which the award of the premiums from the Royal English Agricultural Society to either would confer. I consider all the four wheats remarkably good, and well worthy of general attention; and from my tabular results should be inclined to say that, if a premium is to be given to any, it should be to red No. 2, the produce of which was much greater in quantity than from the other reds.

King's Weston, 22nd September, 1842.

I have sent to Hanover Square specimens of the different kinds of wheat in straw with roots indifferently selected, and samples of each of the seeds sown as well as those grown, together with a small quantity of the soil of the field on which the experiment was carried out, and have likewise added a plant of Egyptian mummy-wheat grown in my garden.

XXX.—*Report on Prize-Wheats.* By G. KIMBERLEY.

I REGRET that my report of the wheats sent me from Liverpool for trial must be very unsatisfactory and inconclusive, in consequence of the incessant rain of last autumn, and the exceedingly harsh and long-continued dry weather of the spring, the wet of the autumn causing a great loss of plant in some parts of the land, and the dry spring having so baked our sandy, loamy soil, that neither harrow nor hoe could make any effectual impression. The land selected for the trial of the four sacks of wheat I received is the best wheat-land I possess, being a sandy loam, with, in some parts, a clay and others a sandy subsoil, and in clover-ley,

from which four pieces were measured of exactly $1\frac{1}{2}$ acre each, 1 acre of each piece being manured with seven large cart-loads of dung, and the remaining $\frac{1}{2}$ acre in each with liquid manure mixed with decomposed peat, at the rate of about 100 bushels per acre, the object being the trial of the manure as well as the wheats.*

The Champion red wheat, No. 4, and the Burwell red wheat, No. 3, were drilled on the 20th of October. The white wheats—the Belle-Vue Talavera, and the Chidham Nos. 1 and 2—were drilled on the 22nd of October; some Silver-drop of my own seed, and some Chidham also, being drilled on the side of the prize-wheats.

The Chidham came up first; the Silver-drop about the same time; and the red wheats, being on the heaviest land in the field, did not appear well up till the 11th of November, and then not a full plant; the Talavera did not make its appearance at all, and, such was the continued rain, that it was found impossible to get on the ground to re-plant it, though several attempts were made. The land soon swarmed with slugs, which, in spite of all our efforts, destroyed a great number of the plants on the best and heaviest part of the ground, so that in the spring it was considered doubtful whether it was worth leaving for a crop. Early in the spring the Talavera was again drilled, and the Chidham, part dibbled in patches where it required as well as we could, the hope of any report being entirely given up; but the Champion and Burwell red wheats (I having no more of the same seed) were weeded and suffered to grow on till harvest, with all the injuries sustained by the crop that I have described. The red wheats came into bloom about the 16th of June, and the Burwell wheat was reaped on the 1st of August, the Champion three days after. The produce is as follows, and a fine sample:—

WHEATS.	Best Wheat.			Seconds.			Tail.			Total.			Weight of best per bushel.	
	qrs.	bls.	pks.	qrs.	bls.	pks.	qrs.	bls.	pks.	qrs.	bls.	pks.	lbs.	ozs.
Burwell	5	0	0	0	4	0	0	2	2	5	6	2	64	12
Champion	6	6	0	0	7	0	0	1	0	7	6	0	64	8

WHEATS.	Weight of seconds per bushel.		Weight of tail per bushel.		Total Weight.		No. of straw in trusses 36 lbs. ea.		Straw. Total weight.		Height of straw.	
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	trusses.		lbs.			
Burwell	62	4	57	8	2987	0	99		3564		about 5 feet	
Champion	61	4	44	0	3955	12	139		5004		6 inches Do.	

* I may mention that the trial of the two sorts of manure was also unsatisfactory from the same cause as the crop above mentioned; but in the

These results, I am aware, can lead to no useful comparison, the plants of the wheats being more or less affected by the weather; but, from a continued observation, I consider them both excellent sorts of wheat. Of the white wheats, the Talavera I have grown several times, with various success; but it is decidedly a spring wheat, and there must be considerable risk in sowing it in our climate in the autumn. Of the Chidham, as a wheat for autumnal sowing, its value is well known and appreciated in this district of country. The Chidham sown for trial was so mixed by the plant being filled up in the spring with Talavera wheat, that any account of it I consider would be useless; but a piece sown adjoining was supposed to contain per acre full 5 qrs., and upwards of 3 loads of straw; the Silver-drop also, on a still lighter part of the field, was considered quite equal to the Chidham, as was also some Suffolk wheat, a valuable variety, in a field very near. It will, of course, be left to the Council generally to decide from the various reports as to whether the wheats selected at Liverpool, for trial for the prizes, are so superior to the sorts in general use as to deserve the approbation and premium that the Society would in that case confer; yet I feel it my duty at once to state, that, though I think the Chidham wheat, as a white wheat, and the Burwell and Champion red wheats, sorts that may be safely recommended to public notice, yet that I do not believe them to be in any way superior to the sorts of wheat now in *general use*. Of the red wheats I think the Champion would bear the heaviest crops, if any difference. Of the Talavera, being a spring wheat, and properly belonging to that class for trial, I consider the autumn-sowing (though it might not have failed) to be an experiment on which we could not safely rely for a crop, or recommend for general practice.

GEO. KIMBERLEY.

Trotsworth, Egham, October 10, 1842.

XXXI.—Report on Prize-Wheats. By H. HANDLEY.

IN furnishing the result of my trial of the Liverpool prize-wheats, I must observe that the season so completely destroyed all chance of doing justice to the experiment, that it will be utterly valueless.

Not having received the wheat until the wet weather of last autumn had set in, I waited in vain for a favourable change, and

small patches where there was a plant no difference in the appearance of the wheat could be observed.

in despair sowed it on the 10th of November, on a very strong clay fallow, tile-drained in every furrow.

I was unable to drill it owing to the state of the land ; I therefore sowed it broadcast, with one-third of a ton of rape-cake per acre, and harrowed it in. The seed covered more favourably than I had hoped, but it eventually lost so much plant that during the frost I top-dressed it with 8 loads of dung per acre ; so that the season, not poverty, has to bear the blame of the result.

The wheats sown were as under—an acre of each :—

	Net weight per 4 bushels.		Quantity per acre yielded.		
	sts.	lbs.	qrs.	bhs.	pk.
No. 1	18	2	1	3	1½
No. 2	18	6	1	3	1
No. 3	18	4	1	7	0
No. 4	18	2	2	0	0
Golden drop . .	18	5	2	1	0
White chaff, red .	18	4	1	6	0

	Comparative weight of Straw.	Date of coming into Ear.		When reaped.
No. 1 . . .	19 lbs.	June	15	Aug. 8
No. 2 . . .	18		24	20
No. 3 . . .	20		20	11
No. 4 . . .	21		22	13
Golden drop	22			
White chaff	26			

So hopeless was the season that I left a considerable portion of the farm unsown till spring, when I substituted barley for what ought to have been wheat. A field on the same farm, sown under favourable circumstances, has averaged me 4½ qrs. per acre.

H. HANDLEY.

XXXII.—*Account of Mr. Irving's New Machine for Constructing Tiles.* By W. FORD.

To R. A. Slaney, Esq.

IN introducing to your notice the newly-invented machine, by Irving, for making draining-tiles, I would remark that it combines the essential recommendations—cheapness and simplicity. It effects great economy in labour, consequently reduction in the price of tiles, and gives superior strength. Any ordinary labourer, after a few hours' practice, is competent to the work, but, of course, the more practice, the more expert, and the quantity would increase with his practice. This is particularly exemplified in brick-making. In most parts of the country 3000 to

4000 per day is considered good work ; whereas, in most of the brick-fields in the neighbourhood of London, 8000 to 9000 are made : I have known 10,000 made. I find few men at first can fill the box and cut the tiles, in Irving's machine, in much less than 4 minutes (containing 16 tiles), but after good practice they will do the work in one minute : yet this is too quick for practical use, as the boys could not wash and take that quantity away, as it would be equal to nearly 10,000 per day of 10 hours' work. But the economy of labour effected by the machine is not confined to the cutting or moulding 16 tiles in this short time, but from the tiles being drawn out together in a heap, like the leaves of a book standing up : it employs two boys, one on each side, to wash off or shape, by placing the horn against the tile as standing, thereby saving the time and risk attendant upon carrying the tiles singly in the hand from the moulder to the horn. Another improvement effected is by the use of a wooden washer, invented and registered by myself, by which the operation of shaping or washing off is not only greatly facilitated, but the crack (particularly in brittle clay) in the tile caused by the bending upon the horn is effectually closed, and great strength given to the crown of the tile. In fact, such is the strength of our smallest tiles that they will support a man standing upon them edgeways. In making the soles for placing at the bottom of the drain-tile (now used in all permanent drainage), nothing can exceed the simplicity and despatch : thus the 16 tiles are drawn out of the box as wire attached to a frame is drawn through the centre, thereby making 32 soles at a time.

In reference to the quantity this machine is *capable* of making, I am perfectly satisfied its full capabilities would rarely be necessary, inasmuch as 3000 per day (equal to nearly 500,000 per annum) would be quite as much as necessary for one establishment : and for this reason, that the AVERAGE quantity of tiles required to drain an acre of land does not exceed 2250 ; and that in the neighbourhood of one tile-work—say 4 miles—the drainage in operation would not exceed 150 acres per annum ; consequently, the quantity necessary for the demand would seldom exceed 337,500 tiles per annum ; that, as the absolute cost of LABOUR in the operation of making drain-tiles, from the digging of the clay to the burning of the tiles inclusive, does not exceed 9s. per thousand, it is therefore my opinion that no establishment need be of greater capacity than to command that space or distance, beyond which the expense of cartage would much exceed half the cost of making ; and, at a moderate calculation, carting is 8d. per ton per mile, or nearly 1s. 4d. per 1000 drain-tiles per mile. Upon this calculation it would be bad economy to erect tile-works capable of supplying a distance exceeding 4 to 5 miles.

Your reference to the new mode of draining with concrete, like the equally new mode by peat, is a good and valuable discovery as applicable to particular localities, but inapplicable for general use, inasmuch as the *material* is not to be obtained in the great majority of cases, but at too great cost for lime, gravel, and cartage, as compared with, in my opinion, the better and more permanent system of tiles with soles. I have seldom seen or heard of effective stone-draining that did not cost more than tiles, although the stone be within an average distance of half a mile of the field to be drained. I will refer you to the very able article on draining, communicated by the Hon. Robert Clive, in the Royal Agricultural Journal, vol. i. Part iii. p. 248; the cost, in that instance, for draining with stone from the ADJOINING field, without any charge for stone beyond the labour and cartage, was 6*l.* 10*s.* per acre: now, had that land, 7*A.* 1*R.*, been drained with *tiles and soles*—tiles at 25*s.* and soles at 15*s.*—it would have cost less than the stone. But of such importance to the country has the operation of draining proved, it is of great consequence that the most permanent, as well as the cheapest, mode should be ascertained; to arrive at which it will be necessary to arrange the descriptions of land requiring draining, from the bog and peat to the pure clay, with the best known practice of draining each, and material for doing it.

I am, Sir,

Yours most respectfully,

W. FORD.

Richmond Wharf, Nine Elms.

XXXIII.—*Agricultural Tour in Denmark, Sweden, and Russia.*

By JAMES F. W. JOHNSTON, F.R.S.

I. DENMARK.

THERE is confessedly much to be done still for British Agriculture. Many good practices may still be introduced from other countries, and many already in use among us may be more widely spread. Many sound precepts also remain still to be generally diffused—by the application of which we may reasonably anticipate that the land will be rendered not only more productive on the whole, but more remunerative also both to the landlord and to the tenant.

And yet a person moderately skilled in agricultural affairs, who has had the opportunity of previously becoming acquainted with some of our best cultivated districts, will soon satisfy himself, when

travelling in foreign countries—that in few other parts of the world is the practical culture of soils like ours more thoroughly understood than in the British Islands—that in none has so great a breadth of land been more scientifically and more expensively improved. It may be that to certain parts of Holland and the Netherlands, and to certain limited districts in Italy, a general superiority must be conceded—and that in every country the traveller visits he will observe something which he may wish to see imitated at home ;—yet in few districts of Europe of large extent will he find united, fields so green, hedge-rows so beautiful, stack-yards so neat—so little waste and unenclosed land—so much artificially drained—so much expensively manured—so many improved and profitable cattle—and, generally, so much visible comfort and skill pervading every branch of the practice of husbandry. This much seems to be due to British Agriculture, even from those who see most clearly its defects and are most anxious to remove them.

Yet this difference in favour of our own island is to be ascribed as much to the circumstances in which it has been placed, as to the superior intelligence and industry of our population. It is easy to write out a system of practical agriculture, by which in a given climate the largest amount of produce of this or that kind may be raised on this or that variety of soil : but when this abstract system comes to be put in practice in this or that country, it is interesting to observe how much it must be altered and modified by the circumstances of that country—how a very bad system of farming theoretically, may be the only one which can be carried on with profit—and may be best suited consequently to the circumstances of the district.

We ought therefore to criticise leniently, and with some hesitation, the agricultural methods we find in operation in other parts of the world. The nature of the soil—the character of the climate—the economical condition of the country—the political relations of the several classes of society—the tenure on which the land is held—the relation which the number of the people bears to the average production of food—the existence of a more ready market, either domestic or foreign, for one or another kind of produce ;—all have a necessary and important influence upon the modes of culture. Hence the candid observer who is in no haste to condemn, will often, when he becomes acquainted with all these circumstances, find himself compelled to admit that rude methods and practices, which are theoretically bad, are, if not the best, yet the most prudent under all the circumstances of the place in which he observes them, and such as he would himself in the like case have adopted.

Of these two truths—the general superiority of British agriculture and agricultural enterprise, and the effect of circumstances in modifying the modes of culture—I observed many illustrations

during a short tour I made in the past summer through part of Denmark, Sweden, and Russia. As some of the circumstances I observed were not without interest to myself, I venture to hope that a few notices of what appeared most worthy of record may not prove uninteresting to the members of the Royal Agricultural Society.

As he ascends the Elbe the stock-farmer will not fail to observe on his left how the marshy lands which skirt the river and stretch for several miles inland, are everywhere dotted with cattle, the herds becoming more frequent and more dense as he ascends, till the pasture is cut off by the bluffs of Blankanaes, where the high sandhills begin to confine the river. To these marshes the lean cattle of the Jutlands are annually driven to be fattened.

From the mouth of the Eyder, in the south of Sleswick, to that of the Elbe, and up the latter river, narrowing as it ascends, this band of marsh-land girdles the south-western part of the Danish territory. That portion which lies on the sea-coast between the two rivers, a district 30 or 40 miles in length, forms the Dit-marsh. The Wilster and Krempe marshes lie on the north shore of the Elbe, in the neighbourhood of the town of Gluckstadt, which is generally admired by the stranger as he ascends the river—and the more so, probably, because the smoothness of the water makes him now forget the pains of the rough sea, and invites him upon deck. From these latter marshes the best oxen are brought to the Hamburg market. These cattle are fattened entirely upon the natural grasses, the culture of turnips being almost wholly unknown, and other artificial food seldom had recourse to except in the neighbourhood of breweries and distilleries.

It is a curious geological fact in regard to the Wilster and Krempe marshes, on which these cattle are fattened, that they are known to be gradually sinking in level. Within the last 300 years they are said to have sunk about 7 feet, and an area of 30 square miles is now 3 feet below the level of high-water in the Elbe. The whole tract is saved from inundation only by the careful preservation of the embankments. On boring, the cause of this sinking becomes apparent. Ten feet of fertile silty clay rest (float?) on 30 feet of water; at the bottom of which is the sand of an ancient sea-beach. How this singular arrangement of land upon water has taken place, it is not easy to explain in a satisfactory manner. My friend Professor Forchhammer, of Copenhagen, to whom I am indebted for the fact, suggests that the silt may originally have been deposited upon a bank of seaweed, and that the slow decay of the latter may have left the vacuity which is now filled with water. However this may be, only long habit, one would suppose, can reconcile people to live

without concern on a spot which a sudden inroad of the sea on a stormy night might entirely swallow up.*

During my short stay at Hamburg I visited a dairy-farm at Ham, a few miles from the city, occupied and apparently well farmed by Mr. Hymers. This farm contains 260 scheffels,† a little more than as many acres, of light land, some of it poor and sandy, but which nevertheless grows wheat better than rye. On this extent of land, which is chiefly in grass, are maintained from 120 to 130 cows, all in milk, but they are partly fed on the refuse of a distillery established on the farm. These cattle are milked till the spring, when they are gradually sold off to the butcher, and replaced by others which have newly calved. They are milked during the whole time of fattening; but their beef, as we should expect, is of an inferior quality. In the market it brings only 10 dollars for 100 lbs., or one-sixth less than the fat oxen from the marshes. I believe a considerable quantity of this second-rate beef from the numerous dairy-farms is sold in the German markets. The milk and cream produced at Ham are carefully bottled and sealed, and are thus sent to the houses of the customers in Hamburg. The former is sold at $1\frac{1}{2}d.$, the latter at $6d.$ a-quart. By this method of bottling, the character of the dairy is maintained, the buyer is secured from fraud, while the milk itself, being less agitated in coming from the country, arrives in a sweeter and sounder state at the house of the consumer.

As good pasture is on this farm of so much consequence, great attention is paid to the top-dressing of the grass-land. The liquid manure is conducted from the large and spacious cow-houses into a cistern outside of the buildings, which is arched over and planted with shrubbery, a square trap-door being left for the insertion of the pump. This cistern is 100 feet long, 14 feet broad, and 8 feet deep, apparently a large size, yet too small still for so numerous a farm-stock. It is capable of containing the produce of three months, which in most cases would appear sufficient, since it is seldom that there is any serious winter before January, so that if the cistern were empty when the cattle

* "In 1421 the sea broke in at Dort, drowned seventy-two villages and 100,000 people, and formed the Zuyder-Zee." This part of Holland, it is supposed, may have originally been in a similar situation with the Wilster Marsh—since it is recorded by an old Dutch writer that in 1420 the proprietor of a farm on the tract of land, which was swallowed up, *found a herring in his well*; and, thinking it unsafe to remain where the sea was evidently undermining him, sold his farm, and removed to another part of the country. The following year the catastrophe came.

† *Scheffel* usually denotes a bushel *measure*. It is in this neighbourhood used to express a quantity of land equal to 200 square poles (*ruten*).

are brought in, they would be turned out again to the spring pasture before it was completely full. But such an adjustment of times and quantities cannot always be conveniently made, and a loss, therefore, now and then occurs. The liquid manure (*jauche*, as it is here called) is applied at almost every season of the year to one field or another, yet it may not always be the most proper time when the cistern is full. Hence the advantage of ample space for a large supply. Upon this conviction Mr. Hymers informed me he was about to erect a second cistern of large dimensions.

English farmers are now, I believe, beginning to understand how very much actual *money* has hitherto been lost in this country by the neglect or waste of the liquid of the stables, cow-houses, and farm-yards. A farmer would not tolerate a servant who wasted the grass or hay intended for his stock, yet *he who wastes liquid manure wastes grass*—diminishing not only his present profits, but his chance of future gains also, for he so far exhausts and injures his landlord's fields. Few are unaware of the benefits derived in many localities from judicious irrigation, and especially where, as in the neighbourhood of Edinburgh and some other large towns, the water of the common sewers can be employed for the purpose. Now the water-cart is only a portable irrigator, and the liquid of the farm-yard is as efficacious as that of the sewers. To collect the former therefore, with care, and to apply it to the land whenever the horses are at leisure, would at little additional expense increase both the produce and the general fertility of many of our farms.

Being so near Hamburg, manure is comparatively abundant at Ham. Mr. Hymers, therefore, manures his land every year, and is allowed to cultivate his arable fields as he pleases. He grows wheat, barley, and potatoes, but no turnips. Wheat yields twelve-fold, and potatoes 6 to 8 tons per acre. Foreign manures are also occasionally applied, such as the fish refuse sometimes brought from Hammerfest in Norway, and, during the last year, the South American guano. About a ton of the latter had recently been applied to the grass-land of this farm: it was then selling in Hamburg at 12*l.* 5*s.* the English ton (10 marks courant for 100 Hamburg pounds).

The rent of land in this part of the country, when at such a distance from Hamburg that milk cannot be readily sent to market, is about 5 or 6 Prussian dollars a scheffel, or 15*s.* to 18*s.* an English acre. There is very much of the sandy land in the neighbourhood of Hamburg that cannot be worth half of this rent.

Hamburg to Kiel, July 5th.—The road from Hamburg to

Kiel crosses the southern part of Holstein, and passes through some of the dreariest parts of this extensive duchy. About one-half of Holstein consists of sandy, unproductive tracts of land, and of what are considered by many as irreclaimable heath and moor. Nearly all the flat and level country, with the exception of the marsh-lands, is more or less of this character. Where it undulates and rises into hills, and especially on the northern and eastern portions of the duchy, the soil changes in character, the unfruitful gravel and sand giving place to occasional clays and to clayey loams and marls, productive in corn and rape, fruitful in milk and butter, and bearing a natural growth of magnificent beech.

The existence of so much comparatively worthless land in Holstein is, I believe, contrary to the general impression not only among ourselves, but, as I have found, in other countries also. This has arisen in part, no doubt, from the fame of the rich alluvial pastures of the marsh-lands on its southern and western borders,* and partly from the fact that the east and north of this duchy—the most frequently seen and visited by travellers—can boast of some of the most picturesque and fertile tracts to be met with in the Danish dominions. To satisfy ourselves that the interior of both Sleswick and Holstein is of greatly inferior agricultural value, we have only to cast our eyes upon a recent map of these duchies, when the few names of places which present themselves will indicate at once the thinness of the population and the smallness of the agricultural produce.

The cause of this comparative infertility is to be found in the geological nature of the deposits with which this district is covered. Within the girdle of rich alluvial (marshy) soil that encircles the western coast of South Jutland, Sleswick, and Holstein, stretches a broad band of flat country covered with a white or grey, naturally almost barren, sand (the *ahl* formation of Forchhammer), in many places lying waste, but which, like the sands of Norfolk, is capable of being brought into cultivation by the aid of the marl and clay which lie beneath, often at an available depth. This sandy zone, which in South Jutland covers more than half the breadth of the Danish peninsula, narrows towards the south, in Sleswick and Holstein, and terminates in a point on the banks of the Elbe, a few miles below Hamburg.

To the east of this naturally unfruitful band, the remainder of

* The three Danish-German duchies of Sleswick, Holstein, and Lauenburg have an area of about 340 square German miles—of which the marsh-lands occupy between 60 and 70, or about one-fifth of the whole. (See Mr. Stanley Carr's paper on the Dairy Husbandry of Lauenburg, in the first volume of this Journal, p. 371.) On Professor Forchhammer's geological map of Denmark they appear to occupy a considerably smaller area.

these three duchies, the whole of the Danish islands—with the exception of Bornholm—and a part of the south of Sweden, are covered with a variable thickness of sands, gravels, clays, and marls, in which rolled stones (boulders) of various kinds and sizes abound, and by the presence of which these beds are almost everywhere characterised. In Zealand and Funen, in some of the smaller islands, and on the eastern part of Holstein and Sleswick, this deposit (the boulder formation) forms an undulating country of hill and dale—of rounded hills and basin-shaped hollows. The whole of this undulating tract is rich in clay and marl, and abounds in marl-pits. Many of the hollows are filled with peat, or, where this has been much dug out for fuel, as in Zealand, with small sheets of water—and the whole of the drier country bears naturally luxuriant woods of beech, or, when in skilful culture, yields abundant crops of rape and corn. Nearly all that is rich in Danish agriculture is to be seen upon the undulating part of this formation.

Chemically considered, this boulder formation differs from the sandy *ahl* formation which lies above it by the large proportion of lime it contains. This lime has been derived, as is shown by the many blocks of chalk that are scattered through this formation, from the ancient destruction of some of the chalk-rocks which still abound in Denmark, and it is not only deposited in nests and layers of marl,—so rich in calcareous matter that it is profitable to dig it up and lay it upon the land—but it is generally disseminated through the sands and clays also in smaller proportion, and thus is a main agent in imparting its natural fertility to a great portion of the country on which this formation rests. But the bottom or lower layers of this same formation consist, where they are best and most extensively seen, of a gravel or sand containing many flints, and in many places *little* lime, and they rest upon dark-coloured beds of a species of clay (belonging to a kind of brown coal formation), which is said to hold out little promise of being useful in improving the flinty layers that lie above it. With this lower sandy and gravelly deposit, containing flints, the *flat* parts of Holstein and Sleswick, which belong to this formation, are covered, and they are in great measure open heaths and moors, or unenclosed commons. Over such a flat the traveller passes on his way from Hamburg to Kiel. When the heath disappears, the soil is in many places a white and blowing sand.

We left Hamburg at 10 P.M., and reached Neu Minster, about half way, early in the morning. The rye which grew near this place appeared to be perfectly ripe (July 6th), much of it absolutely white; the oats short, green, and full of wild mustard. The town shepherd, as we changed horses, was blowing his short melancholy cow's-horn, to bring out the cattle for the daily pasture

on the common land. The sandy soil with few flints, of the earlier part of our journey, gradually gave place to a gravel, in some places deep and full of flints. It is said that over this wide tract of heathy land the flinty gravel and sand are not more than 6 inches in depth, and that the nature of the dark bed beneath gives little hope of amelioration from deeper ploughing. It appeared to me, however, that considerable portions of land here and there were capable of being reclaimed, or, where already in crop, rendered much more productive by judicious drainage. In some of the more level parts of the country it might be difficult to find a ready outlet for the water, but otherwise the making of the drains would be attended with little expense. From such drainage I should expect not merely the removal of superfluous moisture and the gradual amelioration of the climate, but an improvement also in the nature of the subsoil, here said to be unfriendly to vegetation.

The great problem to be solved in many districts, before the soil can be permanently rendered more productive, is the mode of effectually and economically altering the subsoil. This is beyond the reach of ordinary top-dressings and manurings, and even deep ploughing (supposing that by merely bringing it to the surface the quality of the subsoil is materially improved) produces only a partial and temporary change. Draining seems to me to be in general the only way of effectually and permanently altering the subsoil; and this constitutes one of the chief recommendations of its use upon light and sandy soils. The rain, which passes through such soils with comparative ease, washes out from the subsoil those noxious ingredients which are hostile to vegetation, sweetens and salubrifies it to the depth of the drains, and fits it for being brought up to the surface without producing any injurious effect. By such action of the rains upon the thin heathy lands of Holstein the unwholesome clays beneath might be so far purified as to qualify them for being mixed advantageously with the sands and gravels above, while they would at the same time, where left undisturbed, permit the roots readily to descend into their substance in search of food.

About 8 English miles from Kiel the land began to undulate, and at the same time to become more fertile. Though still very light, it produced beautiful crops of oats, barley, rye, and wheat—of each of which kind of grain very extensive fields were seen. The wheat was thick and heavy, and the oats of a peculiarly dark green colour. This soil, as I have already observed, is probably rich in lime, and the natural waste of this substance is supplied from the marl-pits, of which numbers exist at no great distance from the road on the approach to Kiel. Along the skirts of the undulating country also the heath and sandy moor is partially im-

proved, in consequence of the ready access to these deposits of marl.

On some of the otherwise bare slopes of the sandy and gravelly banks by the road side the *mare's-tail* and the *colt's-foot* abounded, the latter confirming the above opinion as to the presence of lime in the soil, and the former showing its power to yield with ease the abundant supply of silica so necessary to the growth of corn.*

A railway has been for some time projected between Hamburg and Kiel; and the Danish government has given its sanction to the plan. It would no doubt be a great benefit to the district, though the prospects of a remunerating return to the shareholders are very doubtful. The slender foundation on which the proposers of this line are content to found their hopes was shown by a paragraph in a Hamburg newspaper which caught my eye at Kiel. The projectors of the Altona and Kiel Railway announced that they *now* believed that the return, instead of being only $2\frac{1}{2}$ per cent. on the outlay, might be safely estimated at $2\frac{1}{3}\frac{1}{2}$ per cent.

* I had no opportunity of inquiring into the mode of cultivation adopted for the *wheat* crops of this neighbourhood, nor whether it differed materially from the improved husbandry of Funen, described in a subsequent page. It appears, however, from the statements of Colonel Le Couteur in his very interesting work 'On the Varieties of Wheat' (pp. 39 and 72), that the Kiel wheat (a very productive variety, known by the name of Duck's-bill, and having 'an exceedingly fine ear') gives a flour which is only fit for making pastry, and is too tenacious for household bread. Now this tenacity is due to the presence of a large quantity of gluten in the flour; and the quantity of gluten is generally supposed to depend upon the quantity of animal or other manure capable of yielding ammonia, which is present in the soil. But we can scarcely, I think, attribute this quality of the Kiel wheat to any high manuring of the land, above the highly-farmed districts of our own island. Does it depend, then, upon the nature of the soil, upon the large quantity of lime it contains, or which is added to it in the form of marl? This may have some influence, since it is said that in the county Down the wheat grown on soils which rest upon limestone is richer in gluten than the other wheats of the county. If so, this would be an interesting fact in regard to the action of lime, and might help Colonel Le Couteur to the kind of soil on which this variety of wheat may be expected to thrive. It would show also that the proportion of gluten in wheat is not dependent solely on the kind and quantity of manure added to the soil.

But another question still remains. Is the proportion of gluten not dependent upon the *variety* of wheat also as well as upon the soil or manure? Would, for example, the Duck's-bill, sown alongside of another variety, and under the same circumstances, produce a flour much richer in gluten than that of the other? This is a very interesting theoretical question; one not unlikely, I think, to be answered in the affirmative, and which is not unsusceptible of an important practical bearing. Perhaps Colonel Le Couteur could throw some light on this question.

The reader will recollect that the nutritive qualities of wheaten flour are supposed by *some* to be almost directly in proportion to the quantity of gluten it contains.

This happy expectation was founded on the introduction of the new manure *guano*, which was to be carried along the line in such quantities as, besides remunerating the shareholders, to convert also the barren heaths and moors of Central Holstein into blooming and productive fields.

Though much corn and rape are grown in the country around Kiel, yet I believe butter is one of the principal articles of export. On some of the farms 200 or 300 cattle are kept, yet on the whole route between Hamburg and Kiel I did not observe a single field-turnip. In Holstein much of the soil is said to be now tired of rape. The cultivator of the land in almost every country is under a strong temptation to raise crop after crop of that kind of produce which finds the readiest sale and yields the largest return. In Great Britain we grow corn as often as we can, and Holstein exhausts herself to supply us with rapeseed, Jamaica to send us sugar, and the United States to give us cotton, tobacco, and rice.

There is a remarkable chemical difference between the straw of the corn-bearing plants and that of rape—the former containing much silica, the latter much potash, soda, and lime.* It is possible, therefore, that a saline manure might ameliorate the soil on which rape has ceased to thrive. Rape-straw spread upon the fields and burned is known greatly to promote the growth of the succeeding crop. A properly adjusted mixture of the saline substance of which the rape-ash consists would form a *rape manure*, from which similar advantages might be anticipated. Even where husbandry is most carefully practised, and as much as possible of all the produce is again returned to the corn-fields, there is always an annual loss of the saline constituents of the soil and crops, carried away chiefly by the rains and drains, which must in some way or other be restored to the land, or it will ultimately deteriorate in quality. A rational practice, therefore, as well as sound theory, indicates the trial, after previous marling, of a mixture of common salt with sulphate of soda, wood-ashes,

* Thus 1000 lbs. of ripe wheat and rape straws, though they left respectively nearly the same weight of ash when burned, yet contained the several constituents of the ash in the following very different proportions:—

	Wheat.	Rape.
Potash	0.2 .	8.8
Soda	0.3 .	5.5
Lime	2.4 .	8.1
Magnesia	0.3 .	1.2
Alumina and oxide of iron	0.9 .	0.9
Silica	28.7 .	0.8
Sulphuric acid	0.4 .	5.2
Phosphoric acid	1.7 .	3.8
Chlorine	0.3 .	4.4
	<hr/> 35.2 lbs.	<hr/> 38.7 lbs.

and bone-dust, on lands which have ceased to yield luxuriant crops of rape.

Kiel to Copenhagen.—The voyage by steam from Kiel to Copenhagen occupies about twenty-four hours. The islands which are passed before reaching the coast of Zealand are Laaland (Lowland), Falster, and Moen. Except a part of the island of Moen, where the soil, a calcareous clay, rests immediately upon chalk, and forms some of the best wheat land in Denmark, these islands, as well as Funen and Zealand, are covered by the same boulder formation which overspreads the eastern half of Jutland, Sleswick, and Holstein. I had no opportunity during my recent visit of personally observing the state of agriculture in these islands, but I was favoured by Mr. Hofman Bang, of Hofmansgave, near Odensee, one of the most zealous and intelligent agriculturists in the island, with much information in regard to the existing state of farming in Funen. The soil there is generally light and sandy, yet, like the similar soils in the undulating district of Holstein, it grows good crops of corn and rape. The custom of taking three white crops in succession used to be general. Among the better class of farmers the course was fallow with manure, rye, barley, oats, clover and rye-grass, and then two or three years' grass—so that only one-eighth of the arable land was manured every year. Among the peasants (small farmers) the artificial grasses are not used; and three white crops, followed by two or three years of grass and a fallow, with manure, is still the prevailing practice. The improved course introduced more recently on some of the large estates is only a step towards the full measure of improvement. This is—1st, naked fallow with manure—2nd, rye—3rd, wheat—4th, potatoes and vetches manured—5th, barley—6th, oats—7th, grass for two or three years. The culture of potatoes is extending, and many are also now grown in Zealand; but, though many cattle are kept, turnips are unknown as a general winter food. Here and there small experimental patches are occasionally seen; and Mr. Bang told me that, besides potatoes, he occasionally raises a few Swedish turnips for fattening his cattle. In Funen the cattle are kept in the house from the middle of November to the middle of May, and are in general fed all the while on straw and hay only—something of the old Scottish system, now, fortunately, a matter of history only, of merely keeping cattle alive till the spring pasture came. Potatoes with chopped straw are now occasionally given. Here, as in Jutland, the cattle are seldom fattened, but are sold lean. In places which are remote from a market the oats are sometimes used up in fattening the stock.

As upon the mainland opposite to it, much butter and cheese

are made in Funen, and considerable attention is at present directed to the improvement of the latter article. The refuse milk is employed in fattening pigs. A mixture of clover, or nettles or other weeds, with water and whey, allowed to stand till it is sour, is also much employed in Holstein and Sleswick in the feeding of pigs, and is said to fatten wonderfully.

In Funen there exists an agricultural society, under the name of the Patriotic Society, which exerts itself in the promotion of a better husbandry. The principal improvements yet effected have arisen by the introduction of better implements and the encouragement of better ploughing. The preparation of composts also, through their exertions, is beginning to be understood and practised. The meadows are dressed with town-manure and wood-ashes; but notwithstanding the wonderful effects it produces in Mecklenburg, a country so near, gypsum has not been found beneficial in Funen. As the same fact has been observed also in Holstein, it is probable that the soils of the boulder formation, which, as I have said, covers so much of the eastern half of Denmark, are already sufficiently impregnated with gypsum or with some other saline sulphates which act in a similar manner upon vegetation.* If this be so, it affords an illustration of the important practical bearing which an elementary knowledge of the geological structure of a country may have upon the operations of the farmer. The future improvers of Danish agriculture have probably little general benefit to anticipate from the employment

* It may even be that this supposed richness in sulphates has been one cause of the known productiveness of the rape crops in these districts, since the straw of rape is so rich in sulphuric acid (see previous note, p. 409). The action of the sulphates is no doubt very much owing to the acid they contain; and they *all* affect in a similar way the same kind of plants as the clovers and other leguminous crops. Yet they act differently also on certain cultivated plants. Thus Mr. Burnett of Gadgirth, near Ayr, informs me that he last year (1841) dressed two parts of a field of turnips respectively with sulphate of soda and with gypsum. The former produced no apparent effect, while the latter *doubled the crop*. At first I fancied that the land might have been destitute of lime, which the plant obtained from the gypsum; but I have since learned that the land had previously been heavily limed. Liebig would say that in this experiment the gypsum had fixed the ammonia of the atmosphere, which the sulphate of soda could not do. I do not coincide with those who thus explain the action of gypsum, for reasons which I have elsewhere stated: but the result of Mr. Burnett is so very interesting, that I would gladly hear of the *accurate* repetition of his experiment.

While this sheet is going through the press I am informed by Mr. Campbell, of Craigie House, near Ayr, only a few miles from Mr. Burnett's, but nearer the sea, that he has this year (1842) dressed part of a field of turnips with 2 cwt. of unburned gypsum per acre, *without producing any apparent effect*. Can the proximity to the sea explain this?

of gypsum, wherever the sand, gravels, clays, and marls of this formation extend.

That *Danish agriculture* in general is in an improving condition is established by the fact that sixty years ago English flour was imported into Denmark; while at present, notwithstanding the increase of population and the more general use of wheaten bread, flour is exported largely to the Brazils and to Jersey, especially in the form of biscuit.* This increase in the growth of wheat must not be considered merely as an indication that a larger amount of agricultural produce is raised in the country than formerly, but also that produce of a more valuable kind is reaped from the land—that by an improved management soils which formerly grew oats, or perhaps rye, are now enabled to grow wheat. In judging of the advance of agricultural improvement, the quality of the produce, whether in corn or cattle, must be taken into account quite as much as the nominal quantity.

Rye is most largely produced in Denmark, being the principal food of the people; and much of this grain has long been exported to Holland, especially from the province of Jutland. Barley forms, I believe, the largest and most valuable exportable corn produce, as the general lightness of the soil would lead us to expect; and both barley and oats are said to be shipped in considerable quantities to England. The increase of these exports is another proof of the progressive advancement, at least of the arable culture of the country.

During the present century much has been done by the exertions of individual proprietors for the improvement of their own estates or neighbourhoods; and an *Academy of Agriculture* has more recently been instituted at Copenhagen by the Government, but no agricultural schools have yet been established. They are much desired and talked of, however; and when the hampered finances of Denmark admit of it, they will most likely be established. In the mean time the more zealous agriculturists send their sons to the Prussian or to the new Swedish schools.

The late King of Denmark did more, I believe, for the improvement of the breed of horses than for any other object immediately connected with the agriculture of the country. In 1829 I visited the royal farm at Fredericksborg in the island of Zealand, and saw the stud, consisting altogether of about 700 horses. From this stud stallions were distributed over all Denmark, to the

* Has the alleged glutinous quality of the Danish wheat anything to do with this export of it in the form of biscuit? Can the geological nature of the surface really affect the form in which the corn it produces can be best *cooked*, either for immediate consumption or for distant transport?

number, I was told, of 200, for the purpose of improving the Danish race of horses. In consequence of this encouragement, the export of horses had become considerable; the number taken out of the country in 1828, according to the official returns, being 14,000. Mr. Bang informs me that this crossing of the Danish breed with the English race has not improved the former for agricultural purposes.

The royal farm at Fredericksborg consists of about 4000 English acres; and I found upon it both Merino sheep and improved breeds of cattle; but I am not aware how far the cattle-breeding provinces have availed themselves during the last ten years of the means of improvement thus placed in some measure within their reach.

Agriculture in Jutland.—Jutland supplies the greater number of the cattle which are fattened in the marsh-lands of Holstein. I may be excused for inserting a few agricultural notes respecting this province, taken during an excursion I made in this part of Denmark in 1829. The progress of improvement may have effected some changes since that period, but upon the whole I believe the following remarks represent very correctly the several points to which they refer.

Sailing from Elsinore I landed at Grenae, on the east coast of South Jutland; thence went by the town of Randers to Randrup, an estate about 30 miles north-east from that town. The soil was generally light and undulating—much of it in pasture, and much in the hollows, where the drain would effect great improvements. The estate of Randrup, the property of Mr. Thygesen, consisted of 800 tonnen of land (14,000 square ells being 1 ton of land), and was chiefly in pasture. Like nearly all the land in this district, it was light and sandy, and reposed, at the depth of 2 or 3 feet, more or less, on a gravelly sand, with many flints and rounded granite pebbles. The surface therefore rested on the same boulder formation of which I have already spoken, probably on its lower and less fertile part. Much manure was not made except in winter, when the cattle were housed, and this was chiefly applied to the arable land. It was not usual in this neighbourhood to take any measures for the physical improvement of the soil. Mr. Thygesen had lately removed almost an entire hill of a yellow calcareous marl, for the purpose of spreading over his fields and making the soil more tenacious—but he had not then been imitated by more than one of the neighbouring proprietors. The practice, however, in a country where marl may be expected to abound, will necessarily make its way. Quicklime was never laid upon the land. The rotation upon this improving estate was:—1st, rye, with marl and manure—2nd, barley—3rd, rye—

4th, oats, with manure—5th, rye—6th, oats—7th, rye-grass, after which the ground remained five years in grass. This was only six white crops in twelve years, but these six were taken in succession.

Rye is the principal food of the people of all classes; comparatively few potatoes are used, and of these such as are small and waxy are preferred in Denmark generally, as they are in Sweden and in some parts of Germany. The larger potatoes are given to the cattle and pigs. I observed a considerable breadth of buckwheat in some parts of Jutland, especially about Grenae. This grain is much used for puddings, for feeding cattle also, and for distillation.

From the Randers district (Randers Amt) I went north to Gudumlund, in the Aalborg Amt, and near the mouth of the Lyme Fiord. Here also the land was chiefly in pasture, and the character of the soil on the higher grounds was nearly the same as farther south. But in this neighbourhood there is a considerable extent of flat, marshy or boggy land, on which the soil is a deep black vegetable mould, and which, in the lower unimproved and not naturally drained parts, is covered with an open coppice of birch, intermingled with hazel and oak, and on the drier places with a brushwood of juniper.

On the estate of Høstemark, at the distance of a few miles from Gudumlund, and which was farmed by its owner, Mr. Hvass, the brother of my kind host the local judge, a considerable portion of this low land had been reclaimed and improved. On this farm the rotation on the sandy soils was:—1st, buckwheat, with manure—2nd, rye—3rd, rye—4th, rye-grass, or woolly soft grass (*Holcus lanatus*), and then three years' grass, the whole of this sort of land being divided into seven portions to suit this rotation. The light black earth of such of the marshy land as admitted of arable culture was ploughed two or three times when broken up and manured, after which it was cropped with barley, vetches or oats, rye, oats, and then sown down with *Holcus lanatus*, and left four years in pasture. There is a large quantity of this marsh-land, or *moss*, as it is there called, which by good drainage would at once be converted into excellent meadow, while that which already admits of arable culture might by the same means be rendered capable of bearing any crop. It all rests upon a substratum of chalk and flints, so that the means of improvement are at hand. It is possibly the existence of this substratum which makes this marshy surface more naturally productive than the peat-bogs of our own country.

This marshy tract is all new land, gained from the waters, probably of an arm of the sea, within a comparatively recent period. Of this, among other proofs, may be mentioned the muscle and cockle shells found over it all, at a depth of 1 or 2 feet,—the

names of places, such as Skipsted (ship station), Segelflod (sail-stream), which are now far from the sea,—as well as the records of sea-fights having taken place where this land now exists. It may be supposed, therefore, that this country of North Jutland partakes in some degree of that elevatory movement by which so much of the opposite land of Sweden and Norway is known to be gradually raised above the level of the sea.

Yet a section observed by Professor Forchhammer on the shores of the Lyme Fiord (at Krabbesholm near Skiva) would appear to indicate that this district has partaken within historic times of an alternate movement, rather than one of continued elevation. Beneath 12 inches of soil, on which natural oak-wood is growing, he found an oyster-bed 8 feet in thickness, and below this, at the sea level, a bed of sand containing deer's-horns and stone axes. It would appear therefore that, since the land was inhabited by a people who used stone axes, it had been submerged in the waters of the sea long enough to admit of this large bed of oyster-shells being formed, and afterwards gradually raised again. This inference in regard to the submersion may not be considered as fully justified, since the relics may have been carried down into deep water, but there seems little reason to doubt that the land has actually risen.

The cattle, which form so important an article of export from Jutland, are chiefly reared by the peasants, sold by them at the age of two or three years to the large farmers or proprietors, who keep them till they are five or six, when they are sold off to the marsh-lands of Holstein and Sleswick, where another season fattens them. In Jutland they are fed during the winter on hay, chopped straw, and buckwheat. The late maturity of these cattle will enable the stock-farmer to judge both of the value of the breed as raisers of beef, and of the money value of the land on which they are fed. The value of the Danish breed cannot be expected materially to improve until the proprietors become themselves the raisers of stock, and by the growth of green food are enabled to promote their growth during the winter as well as the summer.

Most of the land in this district is cultivated by the proprietors, who retain inspectors or overseers at a fixed salary. Some is rented out ready stocked, to tenants who pay a fixed rent for land, stock, and implements together. At the expiry of his agreement the tenant leaves everything as he found it. This system formerly prevailed in certain parts of Scotland. Some of the rents are paid in kind—in corn or butter; and when this is the case the system is similar to the Mezzadria in Italy, only that in Jutland the quantity of produce paid is now fixed; other rents are paid in money. The *Forpagters*, or tenants, are in general so very poor

that this method of stocking by the proprietor is a matter of necessity, if he wish to let his farm at all. In an improving district, however, time may be expected to remove this necessity.

The wages of men-servants are from 26 to 30, and of women from 16 to 20 dollars a-year ($9\frac{1}{3}$ to the pound sterling). When hired for the summer half-year only, a somewhat higher wage is given. In summer they generally have five meals a-day. At four in the morning their *dovre*—beer, bread, and dried or pickled herrings; at eight a *millemad* (mellemmad, middle meal) of bread, butter, cheese, and brandy (to save trouble, a dozen bottles of brandy are generally allowed to each for the summer); at twelve is *middagsmad*—soup made of flesh and vegetables with the meat, or a pudding of buckwheat or barley with milk, and dried fish or fried bacon, with potatoes and beer; at four or five another *millemad*; and at seven, eight, or nine, always a buckwheat or barley pudding made with milk.

The estimated money-rent of land, together with the taxes, amounts to about five per cent. upon the estimated value of the fee-simple—the taxes amounting to nearly one-third of the estimated rental. But the price of land seems to be kept down by the expensive mode of farming it. Thus Mr. Hvass's estate at Høstemark, which consisted of 1400 tonnen of land, of which 600 were wood, 200 meadow, and 500 arable, the rest at present unprofitable, was valued at 30,000 dollars, and he would have let it for 1400 dollars, including taxes, or for 1000 dollars, the tenant paying the taxes besides. The direct taxes on this property were then 350 dollars, which certainly appears high, though they were less in proportion to the value than on most of the neighbouring properties, two-thirds of the arable land having been brought into cultivation since the last government valuation by which the amount of tax was regulated. Mr. Hvass was familiar with the works of Von Thaer and Sir John Sinclair, and complained chiefly of want of capital to carry on his improvements more extensively.

On this farm he raised only so much oats as was sufficient for his own horses, and potatoes, buckwheat, and rye for his own establishment, with an excess of 300 or 400 tonnen (worth 2 Danish dollars a ton) of the latter for exportation. This would barely pay the wages of his servants, of whom in summer, when I visited him, he had no fewer than forty-four. The serfs had been emancipated in his father's time, and since money-wages have been paid it is said that much more work has been obtained from the same number of servants. Yet comparatively little must still be obtained from them, if forty-four servants, male and female, be necessary to perform the work, even in summer, of an estate worth no more in rent and taxes than 150*l.* a-year.

The farm grazed also 160 oxen, 30 cows, 300 sheep, and 28 horses. The milk, butter, and cheese were all used in his own household, and the horses, I was told, were all employed in the farm, except two or three kept for riding and driving. Some of them, however, were no doubt reared for sale. Although the beer and brandy, as well as the other articles of consumption, were all grown or manufactured upon the estate, yet the large proportion of the produce consumed by so extensive a household must have diminished at once the profits and the marketable value of the land.

In the autumn, when the harvest is over, both the peasants and the proprietors along the coast employ themselves and their servants in taking and salting fish for the winter's consumption. Flat-fish is principally taken, and much of it is dried in the sun. The necessity of having large establishments is further increased by the custom of making and manufacturing, as in former times in our own country, nearly all the ordinary articles of dress and furniture required in the household.

One of the most spirited and persevering improvers in Jutland was the late Count Schimmelman, so long minister of finance to his Danish Majesty. At present Count Fries of Friesenburg is one of the most zealous and enterprising. He has imported a skilful inspector from Hanover to arrange the irrigation of his estate, and to promote the extension of a system which is fitted to be of such service in the sandy soils of this part of the kingdom. The government has recently been at the expense of sending four young men into Silesia to learn the method of irrigation practised so extensively in that country.

North of the Lyme Fiord in North Jutland I found the land naked, the soil sandy, often moorish, with tracts of poor pasture, and here and there a few thousand acres in indifferent arable culture. The wind sweeps over this peninsula from the Skager Rack on the west, and from the Cattegat on the east, bearing the salt spray and the drift-sand in some places far inland. Even here, however, the spirit of improvement is not dormant, but capital is wanting. Those who have the desire, the skill, and the ability to improve, have too much of this waste land upon their hands to allow of their speedily bringing the whole into more profitable cultivation.

I made the tour of this district, proceeding from Aalborg, on the Lyme Fiord, to Hiöring, on the west side of the peninsula, and thence to the Skaw, returning by Frederickshavn and Säbye to Hals, at the mouth of the Fiord. We drove through deep sand nearly the whole way—the utmost pace at which a pair of horses could take the driver and myself being usually three miles an hour. I could not help being struck, seeing it then for the first

time, with the apparently barren sandy spots on which rye seemed to flourish. Even the drift-sands near the Skaw bore their thin, but I suppose profitable, crops of this grain. The country, in general, is flat, but through the middle of the eastern half, in a north-westerly direction, runs a long and narrow ridge of sand-hills called the Jutland Aas (pronounced *Ose*), which bears a green pasture, scanty apparently, yet refreshing to the eye amid the sands which present themselves almost without intermission to the eye of the traveller, as he proceeds southwards from the town of Säbye. Of such sand-ridges there are many in Sweden of great length, and called by the same name (sand åser), which have lately attracted much attention from geologists.

Between this ridge and the sea, towards the towns of Säbye and Hals, there lies much improvable land, and signs of improvement were visible, especially in the neighbourhood of the former town. *Spurry* is here sown on the sandy soils for feeding the cattle in winter. It is cut when ripe, and dried into hay. In winter, it is given to the cattle two or three times a-day, was much relished by them, as I was informed, and increased the produce of milk.

A plant which springs up spontaneously, and in such quantities in our own corn-fields, especially in sandy soils, may well be expected to grow luxuriantly on such soils when sown as a crop. It is an important principle, in the practical culture of the land, to grow upon it, at least as an occasional crop, that kind of plant,—weed it may be,—which most delights in or infests it; provided it can be made useful as food for stock, and does not by its roots make the land unclean; (plants even which cattle reject, may be in some cases (in many?) profitably raised for ploughing in as a green manure). On this principle is founded the modern practice of sowing land down with natural grasses; it might possibly be applied to the selection and growth of plants of other families hitherto neglected. I shall advert again to this point when I come to speak of Swedish agriculture.

In Brabant the spurry is much cultivated both for pasture and for ploughing in as a green manure. It reaches its full height, about 12 inches, in five or six weeks, may be eaten off or ploughed in and sown again in favourable years three times in a single season, and a rye-crop may then be taken without manure. It is said that by sowing two crops of spurry—eating both off with sheep—in one season, and a crop of rye in the following, an alternate husbandry may be kept up without manure, under which sandy soils will improve so as to give on each return of the corn-crop a heavier weight of grain.

Von Voght and Schwartz speak of this plant with equal enthusiasm. The former says, “Spurry sown on sandy soils is a better pasture than red or white clover; the cows give more and better

milk, and it improves the land in an extraordinary degree. If the land is to be several years in pasture, white clover must be sown with it. Sown in the middle of April, it is ripe for pasture by the end of May. Eaten off before the end of June, the land is ploughed flat, and sown a second time, when it gives another beautiful pasture in August and September. If rye be now sown, the land is as much improved as if it had received 10 cart-loads of manure per acre. The blessing of spurry, THE CLOVER OF SANDY SOILS, is incredible when it is rightly employed. I sow it on the rye and oat-stubble, and I obtain a beautiful pasture and a manuring equal to 4 or 6 cart-loads of manure per acre.”*

Schwartz, in his account of the Belgian husbandry (ii., p. 33), says—“Without spurry, the Campine,† the best cultivated soil in the world, would have been still a desert. A plant this which requires no manure for itself, and which even when mown, by the residue it leaves, gives back more than it takes from the soil—which demands no fixed place in the rotation, but which is satisfied to come in as an after-crop whenever the soil is at liberty—which, except for the seed, requires no preparation—which is satisfied with a soil on which nothing else but rye will grow—which increases the quantity of milk and butter, and improves their quality—and which, I am persuaded, may be raised with advantage, even on the best soils, provided only they are somewhat light. A proof of this is the land of Waas (Waesland in Flanders), the garden of Europe.”‡

In many parts of Germany Schwartz is regarded as a high authority in practical agriculture, and there is certainly much land in the Jutlands upon which, if its qualities be always such as are above stated, it may be sown with the greatest prospect of advantage. I cannot venture to recommend it to the attention of English farmers in general, because I am aware that it has in former years been so recommended by persons more versant in agricultural practice than myself, without finding much favour in this country; and yet there may be some desolate and unproductive corners of our island on which its use might prove eminently advantageous. It is sown on the stubble for autumn feed near York; but the soil there is not of the kind I should think for which this crop is most especially adapted.

* *Ueber manche Vortheile der Grüner Dungung*, p. 23. In this work Von Voght details the results of many long-continued experiments made upon his own estate at Flottbeck.

† *Kempenland*, a district in Dutch Brabant.

‡ In his later systematic work, however, (*Anleitung zum Practischen Ackerbau*, iii., p. 514,) while he speaks of spurry in terms almost equally high, he distinctly limits his recommendation to poor, sandy soils, and insists upon its value on such especially as will grow neither clover nor grass.

In the preceding observations upon Danish agriculture the reader will perceive that there are peculiarities and deficiencies in the culture of the land in that country, compared with English practice; and yet several things will also strike him as satisfactorily accounting for the differences, and in some measure justifying some of the deficiencies. Thus:—

1st. Denmark grows with ease more food than her population can consume; and, as markets for the excess of produce are not abundant, corn is necessarily low in price, and does not therefore yield so large a return to the grower, or so highly stimulate the arable culture of the land. Hence the prevalence of pasture in Jutland for the raising of cattle, for which there is a constant demand, and in Holstein for the manufacture of butter, which is readily exported. Hence also the growth of other crops, such as rape, for the seed of which the sale is easy, and which, on soils that suit it, yields a greater profit than any other arable culture yet introduced into these provinces. The same reason justifies in some measure (if want of capital were not in most cases a sufficient reason) the neglect of expensive improvements—such as the draining of the land, which in very many localities would not only increase the absolute quantity of corn produced, but would enable the arable land to grow corn of a more valuable kind.

2nd. But the nature of the soil necessarily causes, in many districts, a different mode of cropping from that which prevails among ourselves. The food of the people is, in most countries, originally determined by the peculiar character of the soil. Large tracts of land have proved unwilling, by all the forms of persuasion hitherto tried, to grow anything well but rye and buckwheat, and these sometimes but indifferently. On most of the soils of Jutland these kinds of grain used alone to give a sure return: hence it became the object of the farmer to raise the largest quantity of these varieties of corn; and the national produce became, naturally enough, the national food. And now, when an improving agriculture offers to supply other grain in abundance, the national taste remains; and because the people prefer to live upon rye-bread, much rye must still be raised. The produce of the barley and oat, and more rare wheat lands, is in a great measure exported.

Again, the marsh-lands readily indicate their own most profitable employment. How far their value, as rich pastures, is capable of improvement, I am unable from personal observation to state. That so much other land is in pasture is owing in part, as I have already said, to the more ready market for live stock and for dairy produce; but in part also to a want of capital, which will probably be long unsupplied.

3rd. In regard to the improvements which might be effected in Denmark—supposing that of supplying better implements to be

generally attained, which however is still far from being the case—it will be seen that, in the richer soils, much good might be done by draining; in the dairy districts, by improving the quality of the cheese, so that this as well as butter might become an article of export, and by the introduction of green crops, by which a rich winter-food might be more readily attained; in the breeding provinces, by the general diffusion of a kind of stock which would come to earlier maturity, so that the price of cattle when fit for the butcher might be lessened by the cost of two or three years' feed; in the flat and gravelly or sandy heaths, by a more extensive marling, and by a trial of the effects of the drain; and on the sandy soils, by irrigation for the dry pastures, and by the use of spurry for the loose and naturally unprofitable arable sands.

The reader who shall hereafter travel in the Danish provinces will probably discover many other improvements which capital and time may effect; yet he will not, I trust, fail to give the Danish people credit for what they have already done. If they are, *in some parts of their country, a century behind our most improved districts*, they are at least as far behind them also in wealth, and in the other means by which improvements are effected.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

V.—*Account of Experiments on the Growth of Swedes.* By
W. MILES, M.P.

THE following are the tabular results obtained from the different members of the Society who tried the model experiment on the growing of Swedish turnips during the last year. The conditions were, that the seed should be purple top, to be procured of Mr. Thomas Gibbs, Half-Moon-street, Piccadilly, and that the manures applied should be—

✓ Dung at the rate of . . .	20 tons per acre
✓ Bones	20 bushels per acre
✓ Poittevin or Clark's Compost	26 bushels per acre

with the general understanding that any other manures besides the three above specified might be used, and the results likewise recorded. The rows were to be at the intervals of 18 and 27 inches, and not less than $\frac{1}{4}$ of an acre were to be weighed, the turnips having been previously topped and tailed. Information was likewise to be given by the experimentalists of

1. The preceding crop.
2. The character of the manures.
3. Time of sowing.
4. How often, and what quantity sown.
5. When set out.
6. What disease, if any, appeared.
7. When pulled.
8. The weights of every $\frac{1}{4}$ of an acre, distinguishing distances and the different manures.

No.	Name of Experimentalist—County.	Nature of Soil and Depth.	Preceding Crop.	Character and Quantity of Manures.	Time of Sowing.
1.	Earl Spencer, Chapel Brampton, Northampton.	Light sandy soil, subsoil sandy gravel, 6 in. from surface.	Barley.	20 tons of dung. 20 bushels of bones. 26 bushels of Clark's compost.	12th June, by drill, 27 in. in ridge, 18 in. in level
2.	Mr. Thos. Ferris, Manningford Bohun, Wilts.	Light sand, substratum green sand.	Potatoes.	20 tons of horse-dung. 20 bushels of bones. 26 bushels of Poittevin.	7th June.
3.	Mr. Benett, Pyt House, Wilts.	Freestone, grit.	Barley.	20 tons of leaf dung upon which sheep had been folded. 20 bushels of bones. 26 bushels of Clark's compost. 1 cwt. of nitrate of soda, mixed with 10 bushels of coal-dust, per acre.	3rd and 4th June.
4.	Mr. J. Stratton, Manningford Bruce, Wilts.	Clay soil, subsoil chalk.	Barley.	20 tons of horse-dung. 20 bushels of bones. 26 bushels of Poittevin.	3rd June.
5.	Ditto, ditto.	Light sand soil, subsoil green sand & sandstone.	Potatoes.	20 tons of pig-dung. 20 bushels of bones. 26 bushels of Poittevin. 26 bushels of Clark.	2nd June.
6.	Mr. Miles, King's Weston, Gloucestershire.	Sandy loam upon mountain limestone, shallow.	Wheat.	20 tons of dung. 20 bushels of bones. 26 bushels of Poittevin. 20 tons of mixture, composed of one-third of glue-dross, one-third of road-scrappings, and one-third of coal-ashes.	29th May.
7.	Mr. Pusey.	A strong but shallow loam upon limestone.	Wheat.	20 tons of dung. 20 bushels of bones. 26 bushels of Poittevin. 3 cwt. of urate. 3 cwt. of guano. 20 bushels of peat-ashes.	10th July. The ground having been previously too dry for sowing.

EXPERIMENT. 1841.

How often, and what Quantity.	When set out, how often hoed.	What Disease, if any.	When pulled.	Weight of each Trial per Acre.	
				18 inches.	27 inches.
Once, 3 lbs. per acre.	From July 12th to July 19th.	None.	Dec. 1st.	Tons. cwt. lbs.	Tons. cwt. lbs.
				Dung . . 19 0 0	19 0 40
				Bones . . 18 0 0	19 10 80
				Clark . . 16 4 72	17 16 88
	July 12th.	None.	Jan. 1st and 2nd.	Dung . . 11 5 48	10 7 8
				Bones . . 10 10 44	11 10 88
				Poittevin . . 13 18 24	11 13 10
Once, 3 lbs. per acre.	18 inches 7th July. 27 inches 24th July.	None.	December.	Dung . . 24 4 0	19 1 0
				Bones . . 27 4 0	19 1 0
				Clark . . 22 4 0	16 18 2
				Nitrate of Soda 26 8 0	20 3 0
Drilled, 1½ lb. per acre.	From 19th to 22nd July.	None.	8th and 9th March.	Dung . . 15 12 52	13 14 96
				Bones . . 11 14 104	10 19 85
				Poittevin . . 13 0 39	12 4 25
Drilled, 1½ lb. per acre.	From 12th to 15th July.	None.	From 4th to 8th of January.	Dung . . 16 1 49	14 10 37
				Bones . . 15 11 16	12 12 98
				Poittevin . . 14 12 30	13 2 79
				Clark . . 14 1 22	12 1 0
Once, 4 lbs. per acre.	July 1st, twice hand and twice horse-hoed.	The fly. Slight mil- dew Sept. 6th.	Dec. 8th.	Dung . . 17 4 0	15 18 0
				Bones . . 13 2 0	13 10 0
				Poittevin . . 10 8 0	12 0 0
				Glue-dross . 14 12 0	10 12 0
Ridged.			Feb. 1st.	Dung . . 13 13 40	13 1 36
				Bones . . 14 0 36	9 18 40
				Urate . . 12 5 80	12 5 80
				Poittevin . . 13 1 48	12 1 48
				Guano . . 13 10 16	12 3 16
				Peat-ashes . 8 16 0	10 16 60

OBSERVATIONS.

No. 3. It must be observed that this experiment, though it will give fairly the comparative value of the manures used, will afford no information as to the advantages of wide or narrow widths of rows from each other: the fact is, that the drills at the 18-inch distance were put in by a borrowed instrument which deposited the seed deep, and that seed came up at once; while the other rows (*viz.* those 27 inches apart) did not appear above ground until twenty-four days after, in consequence of the dryness of the soil.

No. 6. The turnips came up at twice, at least three weeks intervening from the first appearance of plant until the whole of the seed had sprouted. The turnips of the first crop which were not damaged by the fly became very good plants, whilst those which appeared last, and which became the great body of the crop, never did well. The quantity of rain that fell in the autumn much improved the turnips sown on the dung; the deficiency of heat was more felt by the turnips sown on the bone, Poittevin, and glue-dross manures than by those on the dung. I had intended to have carried out the experiment in Somerset upon a shallow limestone tract, but the conditions were not fulfilled. A curious fact, however, came out in the application of different descriptions of bones used at the distance of 27 inches. In the one case the bones were procured as they came from the kennels, with the usual quantity of animal matter adhering to them, and crushed at home; in the other, they were brought as refuse from a large button-manufactory, after having been thoroughly cleaned for the purpose of manufacture: the respective proceed was—

	Tons. Cwts.	
Turnips on bones crushed at home . . .	11	8
Ditto on ditto from button-manufactory . .	16	10

No. 7. A large part of the swedes sown with guano did not come up, and it was found that the seed which was encrusted with the manure had not germinated. The rows were, therefore, filled with transplanted swedes. The hares selected those plots which were manured with bones and with peat-ashes, and must have diminished the weight.

From some of the members of the Society who agreed to try the experiment no returns have been received, whilst from others, who from the information given through the medium of the Journal had been apprized of its prosecution, ample details have been collected. It seems to have been tried on various soils with varying effects: its publication, however, may be productive of benefit, inasmuch as it may prove the commencement of a system through which the most accurate details of the cultivation of the same plant in different soils subjected to analogous treatment as far as equal proportions of manures are concerned, may fairly be laid before the agricultural world, thus testing the merits of the treatment much more efficiently than were the results to be obtained from one or two model-farms varying but little in soil or climate. The dissemination of practical knowledge, and the early promulgation of any new methods of culture which may have been proved beneficial, will by such method be ensured, and the Society will most gladly receive such information from its members, suggesting that in all results recorded the same tabular system may be adopted as in this trial, and that any observations made during the progress of such experiments, and not included in the tabular form, may be separately communicated to the secretary.

VI.—*On the Application of Clay to Moor-Land.* By S. SOLLY.*To Ph. Pusey, Esq.*

SIR,—On the subject of your inquiry respecting the application of clay, I wish to communicate the following remarks:—One important property of every kind of clay-marl has been pointed out by Lord Spencer; it gives to lighter soils the necessary solidity,—a circumstance which Berzelius observed had not been sufficiently attended to in Sweden. I have found the intermixture of earths less attended to by large farmers than by the occupiers of small allotments and garden-farmers. In Lincolnshire all the tracts formerly covered with heath retain the name of moorland. This heathy or peaty soil is in general in low estimation, but the ameliorations which have been successful there I shall attempt here. I observed a Lincolnshire labourer wheeling away a gravel-bank to cover his plot of moorland. I asked him what his object was—"To get a crop of rye," was his answer. Lord Spencer has found a top-dressing of sand beneficial to a peaty soil; I intend to bring up a covering of gravel by deep ploughing. I have already found the benefit of it in planting here, as I did with my first attempt in Lincolnshire, where the trees planted twenty years ago on a high gravel bank thrown up in digging a wide and deep ditch have made great progress; some which I planted here last spring in a similar way have withstood the excessive drought of the summer, and are likely to prosper.

I have had two instances of the application of marl by small occupiers, who seem to understand the economy of agriculture in a wonderful degree, particularly one of them, who is incapable of reading or writing. The marl they have the opportunity of using appertains to the lias formation; the lime it contains has occasionally been converted by the decomposition of pyrites into selenite or transparent gypsum, which is called isinglass by the brickmakers. The potash generally existing in clay is not easily detected by the chemist, because he is unable to separate the last portions of any ingredient. The laws of attraction by which substances are held together are not thoroughly understood by any chemist; therefore, instead of trusting to chemistry, it is much better to study the operations of nature, which enables plants to extract from the soil or derive from the atmosphere those elements the presence of which the chemist is unable to detect.

The silvery sand of the heaths, upon which I am operating here, appears to contain no nutriment; nevertheless, in opposition to the opinion of all my neighbours, I am endeavouring to bring it to the surface by deep ploughing; and I hope that by burying the heather sufficiently it will answer the purpose of complete and effectual drainage, a good outfall being secured below by wide and deep ditches, towards which there is a sufficient slope, and the springs being cut off above by the same means. The clay, which underlies this sand and gravel generally at great depth, as is shown by the necessity of deep wells, sometimes rises to the surface, and is good brick-earth when it contains a sufficient proportion of sand; but in general it is either perfectly white, fit for pottery, imparting no impurities to the water of the wells sunk down to it, or

perfectly black, containing lignite, abounding with pyrite, which impregnates the water with the results of its decomposition: the white clay, which does not appear to contain any nutritive matter, is reckoned useful as a top-dressing; the carbonaceous clay is rendered poisonous by the pyrites with which it abounds, from the want of calcareous matter to correct the sulphate of iron produced by the decomposition of the pyrites by the application of lime. Land thus poisoned has been made by lime to yield most luxuriant crops of clover, because gypsum has been formed by the decomposition of the sulphate of iron. But although our heath appears to be totally devoid of any form of calcareous matter, white clover is produced spontaneously by the ashes of the heather. This seems to point out a cheap and easy method of converting the heath-land into sheep pasture; but it would not be durable on a soil which has so little power of retaining moisture. This is one of the benefits conferred by clay on peaty soils as well as on sand; this is also one of the advantages of chalk, which, although it rather assists the transmission of water, retains the last portions of it with great tenacity: this is one of the valuable properties of soils enumerated by Berzelius. I have been strongly advised not to use chalk, by persons who have used it here ineffectually; but I have learnt that good turnips were produced on a heath-farm where chalk was used, and that on another part of it, where no chalk was used, the turnips failed. I am using chalk of the very best kind, free from flints, and very powdery. Some of the chalk near the course of the Thames is rendered detrimental by the presence of magnesia, indicated by the production of Epsom salt. Mr. Anderson, of the Botanic Garden at Chelsea, supposed that from this cause the mud left by the waters of the Thames had produced injurious effects at Battersea; but this I should rather attribute to the salts of iron, the presence of which in the mud of the Thames is indicated in various ways,—by blackening the top leather of boots, and by converting the mortar of the Thames Tunnel into a water-proof cement during its filtration.

I remain, Sir,

Yours, &c.

S. SOLLY.

Poole, Dorset.

VII.—*Simple and Effectual Method of Destroying Rats and Mice.*

By J. STANLEY CARR, of Tüschenbeck.

DURING the twenty-four years that I have “turned my sword into a ploughshare,” I do not think there has been a greater alloy to the pleasures of farming than the destruction caused by rats and mice, their fearful increase in favourable localities, and the hopelessness, in a large establishment, of even checking their devastations. Two years ago, rats of an extraordinary size and fierceness trooped about this old house at night, with a clatter which a little imagination and the stillness of the hour magnified into charges of cavalry; young pigs were torn from the sows and devoured, despite their formidable defence; nor was it possible to calculate anything like the quantity of grain consumed by them.

Several plans were tried for entrapping and poisoning, but our ingenuity fell so far short of their marvellous sagacity, that no sensible impression was made upon their hosts, notwithstanding an unremitting perseverance. However, having declared a war of extermination against the whole race, I rejoice in being now able to communicate to my agricultural friends in England an easy and certain mode of getting rid of this intolerable nuisance. A little manœuvring may be judiciously used to attract the enemy to a suitable position—suppose any unoccupied room in an outhouse, where they particularly abound. Here they should be fed with any favourite food—fish or malt I believe they are fond of—and then with, not a preparation of arsenic, which they are much too clever to touch, but pills, the size of peas, made of equal portions of wheaten flour and powdered sugar, intimately mixed with one-sixtieth part of that weight of dissolved phosphorus—say $\frac{1}{4}$ oz. phosphorus to 1 lb. of flour and sugar; cold water should be added to make the mass manageable, and the pills finally rolled in dry flour, and kept secluded from light and air. A couple of pills may be thrown into each rat-hole, or any quantity left on a plate in a dark situation, by which the double object is attained of attracting the animals by the luminousness of the phosphorus and preserving it from too rapid evaporation. The pills should be replaced as often as eaten, and that without grudging, as, although all the slain may not be found, it may be relied on that “every bullet has had its billet.” Still, in a day or two, many rats will be seen running to water, where they die from excessive drinking. No domestic animal appears to be in danger of eating this preparation except fowls. Dry weather is most favourable to its successful application, as damp, whether of situation or atmosphere, dissolves, and consequently weakens, the phosphorus.

Tüschenbeck, Duchy of Lauenburg,
30th August, 1842.

NOTE.—It should be ascertained that this preparation of phosphorus never takes fire spontaneously.—PH. PUSEY.

VIII.—*On the Use of Lime.* By JOSEPH SYBRAY.

WHEN a tenant enters on a farm, if he uses lime, I would advise him to fetch his lime from different kilns, and lay it down in cart-loads on his fallows; when fallen, spread it over the land, then sow the wheat, taking notice of the respective spots on which the different limes were placed, and adopting afterwards that lime which acts most beneficially on the wheat. The quantity used by me is from 60 to 80 horse-loads per acre, a horse-load weighing $2\frac{1}{2}$ cwt. Some of my neighbours suppose that I put too much lime on my land; but six years back I put on 4 acres of summer fallow 80 loads per acre, an acre being left without; I then burned a kilnfull of lime to finish the 5 acres, which kiln holds 100 loads; I then directed my servant to lay the same quantity on the

remaining acre as the others. I believe he did not understand me, but laid on that acre the 100 loads. I directed him to remove each alternate heap; but the day following being Sunday, it rained before it could be removed. The lime was set out in small heaps the same as manure. I was then obliged to plough it down the same as the rest; I then sowed the wheat, which came up very healthy, and I saw no difference on the one acre, only a darker colour; but in July I could perceive it was stronger; when reaped, I kept the wheat produced from the acre by itself, which was 39 bushels; the remaining 4 acres produced about 36 bushels per acre; leaving 3 bushels more for the strong liming per acre. The whole of the close was seeded down with the usual quantity of seeds; the seeds on the one acre strongly limed were much better than on the remaining 4 acres. This close has been pastured ever since, and to this day the difference may be seen between the one and the four acres. This was done on strong, clayey land.

If only 30 or 40 horse-loads of lime are laid on an acre and harrowed in, I consider it not sufficient to mix with all the soil, and it consequently leaves a harbour for insects: but lay 60 horse-loads of lime per acre, harrow and mix it with the soil, leaving none without; and when a shower of rain comes, examine the furrows, you will there find all sorts of insects dead, such as worms, slugs, beetles, &c.; if only 30 or 40 loads of lime have been laid on, you will find very few dead, indicating the advantage of strong liming.

Snitterton Hall, 22nd January, 1842.

IX.—*On the Feeding of Stock.* By the Rev. W. THORP.

IF I mistake not, Professor Liebig points out in his work just published, '*Organic Chemistry applied to Physiology and Pathology*,' a discovery of no less value to agriculturists than any of those in the agricultural chemistry. It is respecting the *necessity of warmth to animals during the time of their fattening; and also of a due supply being given them of nitrogenized food.* In that splendid treatise, which will be as enduring as the science of medicine, he indicates that the bodies of man and animals are a furnace to be supplied with fuel—that the carbon of the food is the fuel which is burnt or oxydized by the oxygen of the atmosphere taken into the lungs; and the mutual action between the elements of the food and the oxygen conveyed by the globules of the blood to every part of the body is the source of animal heat; that the amount of nourishment required by the animal body must be in direct ratio to the quantity of oxygen taken into the system; that the number of respirations, or the quantity of oxygen absorbed, is smaller in a state of rest than during exercise; the quantity of food must depend upon exercise, and that an excess of food is incompatible with deficient exercise. In order to keep up in the furnace a constant temperature, we must vary the supply of fuel according to the external temperature, *i. e.*, according to the supply of oxygen. *Our clothing is an equivalent*

for a certain amount of food. The more warmly we are clothed, the less food is required, because the loss of heat by cooling, and consequently the amount of heat to be supplied by food, is diminished. The cooling of the body increases the amount of food necessary. "If we were to go naked (p. 22), like certain savage tribes, or if in hunting or fishing we were exposed to the same degree of cold as the Samoyedes, we should be able with ease to consume 10 lbs. of flesh, and perhaps a dozen of tallow candles into the bargain daily, as warmly-clad travellers have related with astonishment of these people. We should then be able to take the same quantity of brandy or train-oil without bad effects, because the carbon and hydrogen of these substances would only suffice to keep up the equilibrium between the external temperature and that of our bodies."

A want of warmth, then, is tantamount to a waste of food, and if we apply this to the want of shelter to our sheep while feeding upon turnips in the winter season, when the temperature of the nights is frequently below the freezing-point of water, and this over 3,000,000 acres of turnips in the kingdom, we shall find the loss of food very great indeed. Mr. Childers of Cantley and Mr. H. S. Thompson of Kirby Hall have upon a small scale fed sheep in sheds during the winter, and the former says that the sheep in sheds consume nearly *one-fifth less food* and make *one-third greater progress* than those fed with the very same food in the open field, or very nearly the same food will feed double the number of sheep. Mr. Morton informed Professor Playfair that 200 sheep in the open field eat 24 lbs. of swede turnips each daily; while another 100, having a covered shed and a yard to run into at pleasure, only eat each 20 lbs. of swedes.*

But besides the waste of food induced by the want of shelter, must be added the want of economy in not using together with turnips food which contains more nitrogen. "The increase of the mass of the body," says Liebig, "the development of its organs, and the supply of waste, all are dependent on the blood, *i. e.*, on the ingredients of the blood, and those substances only can properly be called nutritious, or considered food, which are capable of conversion into blood. To determine, therefore," he says, "what substances are capable of affording nourishment, it is only necessary to ascertain the composition of the food, and to compare it with the ingredients of the blood. But the chief ingredients of the blood contain nearly 17 per cent. of nitrogen, and no part of any organ of the body contains less, and animals cannot be fed on matters destitute of nitrogenised constituents. But vegetable fibrine, vegetable albumen, and caseine are the true nitrogenised constituents of the food of graminivorous animals." And the learned professor's book points out the discovery that these three vegetable substances contain the same organic elements united in the same proportion by weight, and, what is still more remarkable, are identical in composition with the chief constituents of the blood, *viz.*, animal fibrine and albumen. These vegetable principles contain the chief constituents of blood, fibrine

* Comparative experiments regarding the relative feeding properties of different kinds of food are of no value unless the temperature of the places in which the animals are fed be the same.

and albumen, ready formed. Vegetable fibrine and animal fibrine, vegetable albumen and animal albumen, hardly differ even in form. "If these principles be wanting in the food, the nutrition of the animal is arrested; and when they are present, the graminivorous animal obtains in its food the very same principles on the presence of which the nutrition of carnivora entirely depends."

To apply these discoveries to our present mode of feeding sheep on turnips. According to Dr. Daubeny's table,* turnips contain in about 50 tons, or 100,000 lbs. weight,

92,762 lbs. water and carbon.

5,558 fixed ingredients.

1,680 azote.

100,000 lbs.

Now 25 tons, being an average weight for 1 acre of land, will only contain 840 lbs. of nitrogen; hence we may see the necessity of adding grain, as practised by Messrs. Childers and Thompson. The former states that sheep fed with the addition of $\frac{1}{2}$ pint of barley per sheep per day, $\frac{1}{2}$ lb. of linseed-cake, a little hay, and with a constant supply of salt, become ready for the butcher *in ten weeks*, and gain of flesh and tallow 33 lbs. to 40 lbs. per head (one sheep gained 55 lbs. in twelve weeks), and that, with artificial food, 30 tons of turnips will feed 60 sheep,† while on the usual plan of feeding on turnips alone out of doors, the average of the country is that 20 tons of turnips will feed in *sixteen weeks* 10 sheep, with a gain of only 20 lbs. of flesh and tallow. The barley and cake cost 6d. to 10d. per week for each sheep, and *the turnips with this addition thus go eight times as far, or produce eight times the amount of flesh and tallow.*‡ The practice of Belgium is also in strict conformity with the principles here laid down by Professor Liebig, for not only are all their animals kept up and fed in houses, but the mixture called *brassin* consists of the flour of nitrogenous grain mixed together with roots. At all events, *the necessity of warmth to animals during the time of feeding, and the use of those vegetables which contain nitrogen, must ever remain as fixed principles of economy in agriculture*, and without principles, says Cullen, deduced from analytical reasoning, experience is an useless and blind guide.§

* See the following paper.

† Journal of the Royal Agricultural Society, vol. i., part iv., p. 409.

‡ The turnips alone go *four* times as far, for 30 tons feed 60 sheep, while on the usual plan of feeding they would only feed 15 sheep; but the same weight of turnips with artificial food produces also very nearly *double* the amount of flesh and tallow, and therefore goes eight times as far.

§ Moveable sheds are now used for keeping sheep warm during feeding on turnips, so that there shall be no loss to the land from the treading of these animals; or, what is still preferable, one-third to one-half of the turnips may be drawn off, and by giving oil-cake or barley to the sheep which consume the other half on the land, as good barley and seeds may be obtained as if all the turnips had been eaten on the land.

X.—*On the Chemical Constituents of Crops.* By CHARLES DAUBENY, M.D., F.R.S., Professor of Rural Economy in the University of Oxford.

To the Editor.

SIR,—I hasten to apprise your readers of an error which has been kindly pointed out to me by a friend, as occurring in the Table of the Constituents of Crops published in the last number of the Journal, and affecting the whole of the column in which the proportion of azote belonging to the several vegetables is stated. Owing to the omission of a cipher, the quantity of azote given by Boussingault for 10,000 lbs. is represented as that existing in 100,000 lbs., and the error has of course been the means of rendering the numbers in the antecedent column relating to the amount of water and carbon likewise incorrect.

It will be easy for your readers to correct both these errors, by adding in every case a cipher to the numbers quoted in my Table in the column relating to azote, and by calculating the water and carbon from the difference between the amount of the fixed ingredients and of the azote added together, and that of the sum total supposed to have been operated upon.

Thus if in wheat the azote be	.	.	.	.	2,380
And the fixed ingredients	.	.	.	.	2,137
					<hr/>
			Together	.	4,517
Then its carbon and water ought to be	.	.	.	.	95,483
					<hr/>

That being the sum necessary to make up . . . 100,000

But I ought not, perhaps, to forego the present opportunity of cautioning your readers against placing too implicit a reliance on the results of the analyses therein given, whether as relating to the proportion of nitrogen, or to that of the fixed ingredients of the crops.

With regard to the former, Boussingault, who is my authority, has published, in a later number of the "*Annales de Chimie*" than that which supplied me with the numbers quoted in my Table, a fresh series of results concerning most, though not all, of the vegetables enumerated, which, being probably more accurate than the former ones, I will by permission insert; and with regard to the fixed ingredients, I believe many of our first chemists are of opinion, that the results obtained by Sprengel require verification before they can obtain the full confidence of the scientific public.

When indeed we consider the labour, skill, and experience which must be called into requisition for the execution of so difficult and extensive a series of analyses as that quoted in my Table, we cannot help wishing that so great a work had been undertaken under the auspices of a public body capable of furnishing the requisite funds, and by an association of chemists, who could assist each other in their respective labours, and be a check upon the errors into which they might severally fall, rather than by a solitary and irresponsible individual, whatever may be his merits or respectability.

In order, however, to afford to others the means of appreciating the degree of reliance which may be placed upon his numbers, I have set down side by side the amount of ashes obtained by Sprengel and by Boussingault from the same species of crops, from which it will appear that, unless their fixed ingredients in each case vary in different instances materially, they have either not as yet been ascertained with sufficient precision, or were not brought to the same degree of dryness in the two instances, previously to their analysis.

I have the honour to be, Sir,

Your most obedient servant,

CHARLES DAUBENY.

Oxford, Oct. 17th, 1842.

Corrected Table of the Constituents of certain Crops.

	Volatilizable Ingredients, viz.		Fixed Ingredients.	
	Water and Carbon.	Azote in the dried Vegetable.	According to Sprengel.	According to Boussingault.
Wheat . . .	94353	3510	2137	2430
Wheat-straw . . .	96132	350	3518	6970
Oats . . .	95180	2240	2580	3980
Oat-straw . . .	93880	380	5740	5090
Rye . . .	97270	1690	1040	2370
Rye-straw . . .	96907	300	2793	3680
Potatoes (dry) . . .	95854	1500	2646*	3900
Peas . . .	93356	4180	2464	3140
Pea-straw . . .	92719	2310	4971 (crop not dried)	11000 (crop dried)
Clover . . .	96369	2060	1571 (crop not dried)	7760 (crop dried)
Beet-root . . .	92354	1660	5986	6240
Turnips . . .	92762	1680	5558	7580

* Given in the former Table 814, in which state the potatoes contained 68·8 water, and only 31·2 of vegetable matter.

Now as 31·2—814—100—2646.

XI.—*On the Quantity of Minute Ingredients of Soil contained in an Acre of Land.* By JOHN HALL.

To H. Handley, Esq.

SIR,—The near approach of the annual meeting of the Royal Agricultural Society of England has induced me to trouble you with the following remarks on 'Liebig's Analysis of Soils,' because it appears to me that the analysis of soils, as given by him, and set forth in the second edition of his work, edited by Dr. Playfair, is not calculated to be of much utility to practical agriculturists, from the parts or proportions being stated in three figures of decimals; the thousandth part of a unit conveying to the mind scarcely any idea of how much of any earth, salt, or metallic oxide, so represented, is contained in an English acre.

Finding a difficulty in appreciating the relative qualities of the soils analysed, I set myself to discover some easy method of reducing his quantities into pounds weight per English acre, hoping it might be of some practical utility, in forming an idea of what sort and quantity of manure any given soil would require.

I therefore took the specific gravity (from an old table I had at hand) of various earths, rocks, and minerals, and arrived at the conclusion that the surface of a statute acre, 1 foot in depth, may be fairly estimated on an average to weigh 7,000,000 of lbs., or 3125 tons. This would give 5,000,000 lbs. as the weight of the surface of an acre $8\frac{1}{2}$ inches deep (or $8\frac{1}{2}$ in.), or 4,000,000 lbs. at a depth of nearly 7 inches ($6\frac{6}{7}$ in.). I give you the calculation at foot.

The simplest way to look at Liebig's analysis of soils is to read the figures as whole numbers, and consider them to represent so many lbs. in every 100,000 lbs. weight of soil. Then if you multiply any of the quantities by 40, it will give the lbs. weight of the ingredient throughout an acre to the depth of 7 inches; if multiplied by 50, the weight throughout an acre to the depth of $8\frac{1}{2}$ inches; and if multiplied by 70, the weight throughout an acre to the depth of 1 foot.

I will give two examples from the second edition of Liebig's work:—

Analysis of a fertile Soil, page 229, No. 27.

	Per 100 parts (in decimals).	Per acre at $8\frac{1}{2}$ inches depth throughout.
Silica and very fine silicious sand . . .	79.174	3,958,700
Alumina (p. 87)	3.016	150,800
	<hr/> 82.190	<hr/> 4,109,500
Peroxide of iron (p. 87)	4.960	248,000
Peroxide of manganese	0.600	30,000
Carbonate of lime (pp. 98, 99)	2.171	108,550
Carbonate of magnesia (p. 149)	2.226	111,300
Potash, in combination with silica (p. 143) .	0.025	1,250
Soda, ditto (pp. 98, 99)	6.349	317,450
Phosphoric acid (pp. 144 and 148) . . .	0.534	26,700
Sulphuric acid	a trace	..
Chlorine	0.005	250
Humus soluble in alkalies	0.782	39,100
Ditto with nitrogenous matter	0.158	7,900
	<hr/>	<hr/>
This may be read as either 100 parts, or } 100,000 lbs.	100.000	5,000,000

Analysis of a sterile Soil, page 211, No. 5.

Silica with coarse silicious sand	95.843	4,792,150
Alumina	0.600	30,000
	<hr/> 96.443	<hr/> 4,822,150

	Per 100 parts (in decimals).	Per acre at 8½ inches depth throughout.
Brought forward	96·443	4,822,150
Protoxide and peroxide of iron	1·800	90,000
Peroxide of manganese	a trace	..
Lime in combination with silica	0·038	1,900
Magnesia, ditto	0·006	300
Potash and soda	0·005	250
Phosphate of iron	0·198	9,900
Sulphuric acid	0·002	100
Chlorine	0·006	300
Humus soluble in alkalies	1·000	50,000
Ditto insoluble in ditto	0·502	25,100

This may be read as 100 parts, or 100,000 lbs. 100·000 5,000,000

By contrasting the large quantities of any ingredient contained throughout the soil of each of two separate acres, the difference in the composition of such soils appears to be much more strikingly displayed than by merely comparing how many thousandth parts of a unit of any ingredient are contained in one soil, and how many thousandth parts of a unit of the same ingredient are contained in another.

If this hint should be found useful to any parties who may wish to examine into Liebig's analysis of soils, or should give some idea of the large scale on which nature fertilises (I might say manures) land, I shall be amply repaid for my trouble, and remain,

Dear Sir, very respectfully yours,
JOHN HALL.

Specific Gravities.

	From	To
Chalk	2252 oz.	2657 oz. per cubic foot.
Dolomite	2540	2830
Felspar	2438	2700
Flint	2582	2582
Granite	2613	2956
Gypsum	1872	2288
Selenite	2311	3000
Oxide of iron	3573	3573
Magnesia (carbonate of)	2220	2612
Limestone	2386	3000
Quartz	2624	3750
Calcareous spar	2837	2837
Coal	1020	1300 { as a representative of humus.
	13)31,268	13)36,085
Average	2,405 oz. or 150 lbs.	2,776 oz. or 173½ lbs. per cubic foot.

An acre contains 4840 square yards, or 43,560 square feet : 1 foot in depth throughout would be 43,560 cubic feet of soil. Assuming an average specific gravity to be 160 lbs. per cubic foot, 43,560 cubic feet would weigh 6,969,600 lbs., which for convenience may be called 7,000,000 lbs.

No. 2, *Mersey Court, Liverpool*,
9th July, 1842.

NOTE.—May we not ask chemists whether an intimate mixture of all the ingredients above enumerated in the analysis would form a soil similar to the one analysed? Would the sulphuric acid remain uncombined with the peroxide or protoxide of iron, or the chalk, potash, and soda? or would they not form neutral salts? Would the chlorine remain uncombined? It may be very interesting to know all the elements contained in any soil; but unless we know how they are combined, and how their combination affects fertility, we are not much more advanced. In comparing the two soils here analysed—one of which is fertile and the other barren—we are surprised to find that the last contains 75,100 lbs. of humus and the first only 47,000 lbs. per acre. What are the elements which may be the cause of barrenness in the one and fertility in the other, if we leave out the different size and quality of the silicious sand and alumina, carbonate of lime and magnesia? The first contains four-fifths of *fine* silicious sand, and 3 per cent. of alumina, with 4 per cent. of carbonate of lime and magnesia. The other contains 95 per cent. of *coarse* silicious sand, with little more than $\frac{1}{2}$ per cent. of alumina, and no carbonate of lime. These circumstances, which the roughest analysis would have discovered, are sufficient to account for the difference between fertility and barrenness. The other ingredient throws no light on the subject as far as the farmer is concerned.—W. L. RHAM.

XII.—*Experiments with Guano.* By GEORGE PRYME.

To the Secretary.

SIR,—I now detail to you my two experiments with guano manure. I made them on a highland and a fen farm, both in my own occupation, in the parish of Wistow, 7 miles N.E. of Huntingdon.

The surface of the former is very undulating, and its soil, though of the same nature, varies somewhat in tenacity. I have had a portion of it analysed by Mr. R. Phillips, of the Geological Museum, Craig's Court. He informs me that "56 ozs. of the soil contained $1\frac{1}{2}$ oz. of silicious stones. These were picked out previous to analysis, not being considered as constituting a part of the real soil. One hundred parts of the soil thus separated from the stones gave very nearly as under :—

Silica or silicious earth . . .	68·9
Alumina or clay-earth . . .	9·7
Oxide of iron	8·1
Carbonate of lime or chalk . .	2·8
Vegetable matter	4·0
Water	6·5

100·0 "

The guano was of a brown colour, and obviously contained some admixture of sand. It was drilled with barley last spring, in the proportion of about $1\frac{1}{2}$ cwt. to the acre. The land was near to that analysed, but of a lighter or less tenacious nature; and was in the middle of a field, to which no other manure was applied. The barley came up of a better colour than that in the other parts of the field, which it kept for a month; then suddenly altered, and looked worse than the other part until it came in ear; after which there was no perceptible difference. The crop was rather a light one.

The soil of the fen consists naturally of decomposed peat or other vegetable matter. The surface soil is black, and varies in depth from 5 to 9 inches. Beneath this is a brown peat, much less decomposed; and at the depth of about 5 feet is a brown clay. It has been found very beneficial to make trenches and throw some of this clay to the surface; but the rain gradually washes it down. This land had been clayed in the year 1836, and some remains of it are still visible. The guano was drilled with barley in the same proportion; and also in the middle of a field of uniform fertility. The barley had a better appearance during the first month of its growth. The whole then became alike, and was a heavy crop. I did not see it at harvest-time; but Mr. Thomas Fairley, jun., my intelligent bailiff, informs me that "neither he nor the men could distinguish any difference between that which was sown with guano and that which was not:" and that, in his opinion, it has on both lands been "a complete failure."

I was chiefly tempted to make these experiments by the accounts of those which had been stated in the Journal of the Society to have been successful: and I can only reconcile the apparent contradiction on the supposition that the different nature of the soils occasioned such very different results. It has long appeared to me that the usefulness of the papers on manures in the Journal is much lessened by the very imperfect account often given of the nature of the soil on which the experiments are tried. Till this be far more carefully and scientifically attended to, the agriculture of crops can make but little progress. In the seven or eight experiments with nitrate of soda detailed in former numbers of the Journal some lands were found to yield an increased produce of much greater value than the cost of the nitrate; some about equal, some less. The difference probably arose in a great measure from the different nature or component parts of the soil. Yet this is imperfectly stated in nearly all the cases; and in one of them not the least hint is given of the kind of soil on which it was tried.

I am, Sir,

Your obedient servant,

GEORGE PRYME.

Cambridge, 29th October, 1842.

XIII.—*New and Economical Oil-Cake.*

LORD BRAYBROOKE has called the attention of the Council to a pamphlet entitled '*Suggestions on Fattening Cattle with Native instead of Foreign Produce,*' which has recently been published by Mr. John Warnes, jun., and attracted much attention in Norfolk. His object is to induce the British farmers to cultivate flax, and to fatten cattle with a compound made of three parts of barley and one of linseed ; which is said to answer the purpose as well as foreign oil-cake, and to be obtained at much less cost. Lord Braybrooke has signified his intention of laying before the Council, for the consideration of the Journal Committee, the results of the experiments on this interesting subject now in progress in the neighbourhood of North-Walsham.

END OF VOL. III.

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Royal Agricultural Society of England.

1841—1842.

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Meeting at Bristol.

Principal Day of the Show, THURSDAY, JULY 14th, 1842.

A GENERAL MEETING of the Members will be held at Bristol on FRIDAY, JULY 15, 1842,
at Twelve o'clock precisely.

THE PRIZES ARE OPEN TO GENERAL COMPETITION.

Prizes for Improving the Breed of Cattle.—1842.

SHORT-HORNS.

CLASS

1. To the owner of the best Bull calved previously
to the 1st of January, 1840 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
2. To the owner of the best Bull calved since the
1st of January, 1840, and more than one
year old Twenty Sovereigns.
3. To the owner of the best Cow in milk Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not ex-
ceeding three years old Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer Ten Sovereigns.

HEREFORDS.

1. To the owner of the best Bull calved previously
to the 1st of January, 1840 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
2. To the owner of the best Bull calved since the
1st of January, 1840, and more than one
year old Twenty Sovereigns.
3. To the owner of the best Cow in milk Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not ex-
ceeding three years old Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer Ten Sovereigns.

DEVONS.

1. To the owner of the best Bull calved previously
to the 1st of January, 1840 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
2. To the owner of the best Bull calved since the
1st of January, 1840, and more than one
year old Twenty Sovereigns.

Prizes for the Meeting at Bristol.

CLASS

3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . . Ten Sovereigns.

CATTLE OF ANY BREED, OR CROSS:

Not qualified to compete as Short-horns, Herefords, or Devons.

1. To the owner of the best Bull calved previously to the 1st of January, 1840 . . . Thirty Sovereigns.
To the owner of the second-best ditto ditto . . . Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1840, and more than one year old . . . Twenty Sovereigns.
3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . . Ten Sovereigns.

HORSES FOR AGRICULTURAL PURPOSES.

1. To the owner of the best Cart-Stallion of 4 years old and upwards . . . Thirty Sovereigns.
To the owner of the second-best ditto ditto . . . Twenty Sovereigns.
2. To the owner of the best two years old ditto foaled since the 1st of January, 1840 . . . Fifteen Sovereigns.
3. To the owner of the best Cart-Mare and Foal . . . Twenty Sovereigns.
To the owner of the second-best ditto . . . Ten Sovereigns.
4. To the owner of the best two years old Filly . . . Ten Sovereigns.
5. To the owner of the best THOROUGH-BRED STALLION, which shall have served Mares at a price not exceeding three guineas, in the season of 1842 . . . Thirty Sovereigns.

S H E E P.

Prizes for Improving the Breed of Sheep.—1842.

LEICESTERS.

CLASS

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling Ewes . . . Ten Sovereigns.
To the owner of the second-best ditto ditto . . . Five Sovereigns.

SOUTH DOWNS, OR OTHER SHORT-WOOLLED SHEEP.

CLASS

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling
Ewes Ten Sovereigns.
To the owner of the second-best ditto ditto . . . Five Sovereigns.

LONG-WOOLLED SHEEP :

Not qualified to compete as Leicesters.

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling
Ewes Ten Sovereigns.
To the owner of the second-best ditto ditto . . . Five Sovereigns.

PIGS.

1. To the owner of the best Boar Fifteen Sovereigns.
To the owner of the second-best ditto Five Sovereigns.
2. To the owner of the best breeding Sow Ten Sovereigns.
3. To the owner of the best pen of three breeding
Sow-Pigs of the same litter, above four and
under nine months old Ten Sovereigns.

IMPLEMENTS.

- | | |
|--|---------------------|
| Subsoil Plough | Fifteen Sovereigns. |
| Double Furrow Plough | Ten Sovereigns. |
| Turnwrest Plough | Five Sovereigns. |
| Wheel Plough | Five Sovereigns. |
| Swing Plough | Five Sovereigns. |
| Open Furrow Draining Plough | Five Sovereigns. |
| Mole Plough | Five Sovereigns. |
| Set of Draining Tools for Tile or Stone, or partly
one and partly the other | Five Sovereigns. |
| Scarifier, or other Implement for stirring or cleansing
the Soil | Twenty Sovereigns. |
| Drill for Corn and general purposes | Thirty Sovereigns. |
| Turnip and Manure Drill | Twenty Sovereigns. |
| Horse Hoe | Ten Sovereigns. |
| Chaff Cutter | Ten Sovereigns. |
| Corn Cleaner | Ten Sovereigns. |
| Cake Crusher | Five Sovereigns. |

Prizes for the Meeting at Bristol.

Turnip Cutter	Five Sovereigns.
Churn, worked with horse or other power (not hand-power)	Ten Sovereigns.
Churn, worked with hand-power	Five Sovereigns.
Cheese Presser	Five Sovereigns.
Haymaking Machine	Ten Sovereigns.
Horse Rake	Five Sovereigns.
Harrow (of any construction)	Five Sovereigns.

Amount for distribution by the Council, on the Report of the
Judges, Ninety-five Sovereigns.

CHEESE.

To the Exhibitor of the best Hundred-weight of Cheese (of any kind)	Ten Sovereigns.
To the Exhibitor of the second-best ditto (of any kind)	Five Sovereigns.

EXTRA STOCK, ROOTS, AND SEEDS.

For Extra Stock of any kind, not shown for any of
the above Prizes, and for Roots, Seeds, &c.,
Prizes may be awarded and apportioned, by the
Committee and Judges, to an amount not ex-
ceeding in the whole Fifty Sovereigns.

ANY NEW IMPLEMENT.

For the Invention of any new Agricultural Implement, such sum as
the Society may think proper to award.

SEED-WHEAT.

I. Thirty Sovereigns, or a Piece of Plate of that value, will be given to
the Exhibitor at the Bristol Meeting of the best 14 bushels of White
Wheat, of the harvest of 1841, and grown by himself.

II. Thirty Sovereigns, or a Piece of Plate of that value, will be given
to the Exhibitor at the Bristol Meeting of the best 14 bushels of Red
Wheat, of the harvest of 1841, and grown by himself.

[12 bushels of the wheat will be sealed up by the judges, and one of
the remaining bushels of each variety will be exhibited as a sample
to the public. At the General Meeting in December, 1843, the
prizes will be awarded.]

The three best samples of both red and white wheat, without distinguish-
ing at that time between the three, will be selected by judges appointed at
the Meeting at Bristol, and will be sown, under the direction of the Society,
in the autumn of 1842, by three farmers, who will make their report, upon
which the prizes will be awarded. Ten Sovereigns will be given at the
Meeting at Bristol to the Exhibitor of each of these three samples, on
account of his Wheat thus selected for trial.

* * No variety of Wheat which has been selected for trial at any previous
show shall be qualified to compete.

GENERAL REGULATIONS FOR EXHIBITION.

I. No stock can be admitted for exhibition unless the necessary certificates, filled in, on the printed form prescribed, and signed by the exhibitor (or his agent), in the manner directed, have been delivered to the Secretary, or sent (postage free), so as to reach the Society's house, No. 12, Hanover Square, London, on or before the 14th of June next; after which day no certificates will be accepted. Proper admission-tickets, corresponding to the certificates, will be sent to the exhibitors, and be required to be delivered with their animals on presenting them for admission into the Show-yard; when the printed numbers will also be required to be affixed to each animal, respectively, by the persons who are in charge of them.

II. The name and residence of the breeder of each animal exhibited, when known, should be stated.

III. Non-members will be required to pay five shillings for every head or lot of live stock before obtaining tickets of admission to bring their stock into the Show-yard; and this amount must be remitted by means of post-office order, made payable to the Secretary, and enclosed with the certificate.

IV. The same animal cannot be entered for two classes; and in all cases the age of an animal is to be computed from the day of birth, excepting in the case of horses, when the year only will be required.

V. No animal which won a first prize in any class at the previous meetings of the Society will be allowed to compete for a similar prize at the meeting at Bristol.

VI. The sheep exhibited for any of the prizes must have been really and fairly shorn between the 1st of May and the 1st of July, 1842, both days inclusive.

VII. Persons intending to exhibit Extra Stock must give notice to the Secretary on or before the 14th of June next.

VIII. Any person who shall have been proved, to the satisfaction of the Council, to have been excluded from showing for prizes at the exhibition of any society in consequence of having been convicted of an attempt to obtain a prize by giving a false certificate, shall not be allowed to compete for any of the prizes offered by the Royal Agricultural Society of England.

IX. In case any gentleman, or number of gentlemen, wish to offer a prize for any class of stock not distinctly specified among the prizes offered by the Society, he or they will be allowed to offer such prize at the meeting at Bristol; and the stock which shall compete for such prize shall be exhibited, subject to such conditions as shall be decided upon by the Council; and the prize awarded by such of the judges as the Council shall select. Animals exhibited for such prizes shall not be prevented from competing for any of the prizes offered by the Society for which they are qualified.

X. Stock of every description can only be admitted into the Show-yard on the presentation with them of the proper tickets, and between the hours of eight in the morning and eight at night, on Tuesday the 12th of July; and must remain in the Show-yard until after six o'clock

in the afternoon of Thursday the 14th of July; and no animal can be removed from its place, or taken out of the Show-yard, without leave in writing from the Stewards; nor will they be allowed to be removed from the yard until after ten o'clock on the morning of Friday the 15th of July, without leave in writing from the Stewards of the yard.

N.B.—Stallions only may be removed for the night.

XI. Persons intending to exhibit Seed-wheat, Implements, Seeds, Roots, Cheese, &c., must give notice to the Secretary of the Society, in Hanover Square, London, on or before the 14th of June, and furnish him with a description (written on one side only of the paper) of the articles intended to be shown, and the probable space which may be required for them (bearing in mind that the sheds are only 16 feet wide), in order that the Stewards may be enabled properly to apportion the space allotted for the exhibition of such articles among the various parties making application; and the articles to be exhibited must be brought to the Show-yard either on Friday the 8th, or Saturday the 9th of July, between the hours of eight in the morning and six in the evening; as none will be admitted after those days.

XII. Whenever reference is made to weights and measures, it is to be considered that the imperial weights and measures only are referred to.

XIII. The Judges of Stock are to have the whole of Wednesday, the 13th of July, for making their adjudication, and signing their award; and the Stewards are instructed to take care that no Governor or Member (including the Council), stranger or competitor, be admitted, under any pretence whatever, into the yard on that day, until the Judges have completed their awards.

XIV. No prize will be given when the Judges shall be of opinion that there is not sufficient merit in the stock, implements, &c., to justify an award, especially in cases where there is no competition.

XV. All persons admitted into the Show-yard shall be subject to the rules, orders, and regulations of the Council.

A SALE BY AUCTION, of Stock and other articles exhibited at the Meeting, will take place in the Show-yard, on the morning of Friday, the 15th of July, at ten o'clock precisely, the Society paying the Auctioneer for his attendance on the occasion. Any Person intending to offer for sale Stock or other articles exhibited, must give notice on his Certificate to be sent in by the 14th of June; and no person will be permitted to withdraw such entries of Sale unless forfeiting Five Shillings for every head or lot of Stock, or other articles of exhibition, so entered.

* * * Further information respecting regulations of detail may be obtained from the Secretary, at 12, Hanover Square, London.

INSTRUCTIONS TO THE JUDGES.

As the object of the Society in giving the prizes for neat cattle, sheep, and pigs, is to promote improvement in breeding stock, the Judges, in making their award, are instructed not to take into their consideration the present value to the butcher of animals exhibited, but to decide according to their relative merits for the purpose of breeding.

In the Class for Horses, the Judges, in awarding the prizes, are instructed, in addition to symmetry, to take activity and strength into their consideration.

ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

Prizes for 1843.

PRIZE ESSAYS.**1. ARTIFICIAL FOOD FOR CATTLE OR SHEEP.**

Twenty Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best mode of ascertaining the relative value of different sorts of Artificial Food for Cattle or Sheep.

Competitors will be required to attend to the following conditions in their prosecution of experiments on this subject:—

1. One or more head of cattle or sheep to be put to each of the sorts of artificial food selected for trial.
2. To ascertain by measurement or weighing the state of the animals when first put to feed, and at given intervals afterwards.
3. When the increase has been ascertained at the end of one or two months, the experiment to be reversed, and the animals put to the sort of food which in the first month was consumed by their competitors, and the increase ascertained in a manner similar to that applied in the first month.
4. In all cases, the quantity of food consumed by each class of cattle or sheep to be accurately stated.

2. NATURAL FOOD FOR CATTLE OR SHEEP.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best mode of ascertaining the relative value of different sorts of Natural Food for Cattle or Sheep.

Competitors will be required to attend to the same conditions in reference to this prize as in the preceding.

Prizes for Essays and Reports.

3. HORSE AND OX TEAMS.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Comparative Advantages in the Employment of Horses and Oxen in Farming Work.

Competitors will be required to attend to the following conditions:—

1. The age and breed of both horses and oxen, with the time at which they were first put to work, must be accurately stated.
2. Both horses and oxen to be in good working condition, and regularly employed on the same farm (stating the nature of the soil) during a whole year.
3. The amount of work, whether on road or field, of each pair of horses and oxen; together with remarks upon the manner in which that work has been performed; and its separate value.
4. The cost of maintenance and farriery of each pair of horses and oxen; including the separate charge for management.
5. The cost, or presumed value, of each pair of horses and oxen, with their gear, when put to work; and their value at the close of the comparison.
6. The comparative number of oxen or horses which are required to do the same work.

4. ON THE CONSTRUCTION OF COTTAGES.

The Gold Medal, and Mr. Slaney's addition of Ten Sovereigns to the prize, will be given for the best Treatise on the Form and Construction of Agricultural or other Cottages, with the Outbuildings and Conveniences belonging to them; together with suggestions for the best methods of constructing Chimneys, Fire-places, Ovens, Floors, Roofs, and whatever may conduce to the health and comfort of the occupiers; to comprise Plans, Elevations, and Estimates, in which due regard is to be paid to reasonable economy.

5. ON THE DRAINAGE OF LAND.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best Mode of Under-draining Land, regard being had to variety of Soil, Sub-soil, and other local circumstances.

Competitors for this prize will be required to give information on the following subjects of inquiry:—

1. Depth and frequency of drains.
2. Materials, tiles, stone, or peat.
3. Filling in, whether with tenacious or porous earth.
4. Expense of the various methods.
5. Disposition of drains.
6. Fall required.
7. Direction of drains on land having a considerable slope.
8. Benefit in increasing crop, admitting new modes of culture and stocking, advancing the time of harvest, reducing the amount of horse-labour required on heavy clays, improving climate, &c.
9. Durability of drains.
10. Past and present practice of draining in England.
11. Districts of England which require the most extensive efforts in under-draining.

6. ON LIQUID MANURE.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Account of Results obtained in the application of Liquid Manures, as artificially obtained by composition, or as occurring in their ordinary and natural state.

Competitors will be required to attend to the following points, in the case of each of these classes of liquid manure :—

Artificial Liquid Manure.

1. The nature of the substances either dissolved or suspended in liquid manures *artificially* composed.
2. The soils to which they are best adapted ; and whether to pasture or arable land.
3. The quantity, mode, and season of their application.

Natural Liquid Manure.

1. The nature of those *naturally* combined ; as the urine of cattle and of man, the drainings of stables and farm-yards, &c.
2. Their mode of treatment and preservation.
3. Their application both to pasture and arable land ; the soils and crops to which they are best adapted ; their chemical properties ; and the probable causes of their success or failure ; together with observations on the quantity to be employed on clays and turnip-lands.

7. MANAGEMENT OF FARM-YARD MANURE.

Fifteen Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Mode of Management and Application of Farm-yard Manure.

Competitors will be required to state—

1. The season when made.
2. The materials of which it is composed.
3. The crops for which it is intended.
4. The period of the year when applied.
5. The mode of applying it.

8. ON ARTIFICIAL MANURES.

Fifteen Sovereigns, or a Piece of Plate of that value, will be given for the best Account of Artificial Mineral and Vegetable Manures, and of the simplest and most effective mode by which their adulteration with spurious substances may be at once detected.

The following information will be required in the case of each of these classes of artificial manure :—

Mineral Manures.

1. The different *inorganic* or mineral substances which have been recommended and used as portable manures ; distinguishing the simple from the compound.

2. The quantities applied per acre; mode and time of application, whether to grass or arable land; and nature of the soil.
3. The probable causes of their success or failure.

Vegetable Manures.

1. The different *organic* and *composite* manures, whether artificially or naturally combined; and their chemical constitution.
2. The quantity used per acre; the time and mode of their application, and whether to pasture or arable land.
3. The soils to which the several kinds are best adapted, and the probable causes of the more certain and constant effect produced by them than of the inorganic kinds: as also, the causes to which their occasional failure may be attributed.

9. WATER-MEADOWS AND UPLAND PASTURES.—1844.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Comparative Value of Water-meadows and Uplands generally for Cattle, Sheep, and Horses, but especially for Milch Cows.

Competitors will be required to state the following particulars in reference to the trials instituted for the purpose of obtaining practical results on this subject:—

1. The nature of the soil and its state of drainage, to be described; and equal portions of upland and water meadow to be selected.
2. Equal numbers of cows of the same age and breed (not less than four in number), to be separately fed in pairs, on each different kind of grass, and to be changed once from one kind of grass to the other; and the quantity, as well as the quality, of the milk from such cows to be ascertained by the lactometer.
3. If made into hay, the quantity of each sort produced on the land, and the quantity, as well as quality, of the milk which has been produced, to be ascertained in a similar manner.
4. The value of spring food and grass, whether in rowen or pasture.
5. The same conditions to be applicable to the feeding of sheep-stock; stating the numbers which the same quantity of each land have separately maintained during a certain period; and whether or not subject to the rot by the flooding.
6. In regard to irrigating the land: the primary cost, whether of catch-water or flow-meadow, of its formation, and the annual expense of management, including the repair of sluices; together with the former and present rent or value.

[Competitors are also requested to state, as far as their observation may have extended, the comparative value of the grasses of water-meadows and uplands, when cut into hay, and consumed as fodder.]

10. PRODUCTION OF FAT AND MUSCLE.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Explanation of the Causes which appear to determine the Production of Fat and Muscle respectively, according to the present state of our knowledge of Animal Physiology.

Competitors will be required to point out—

1. The connection between certain recognised signs of early maturity, as smallness of bone, shape of the ears, mellowness of skin, &c., with the determination of the animal frame to produce fat or muscle.
2. The tendency of certain articles of food to fatten stock, and the adaptation of others to maintain the general frame in a growing state.
3. The disposition of certain breeds to secrete fat externally, and of others internally.
4. The mode in which beans and acorns occasion hardness of flesh in the animals fed on them.

These Essays, except No. 9, must be sent to the Secretary, at 12, Hanover Square, on or before March 1st, 1843.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. That all information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books, or other sources.

2. That drawings, specimens, or models, shall accompany writings requiring them.

3. That all competitors shall transmit a sealed note, containing their names and addresses, with a motto on it to correspond with the one inscribed on the Essay.

4. That the Society shall have the power to publish the whole or any part of the Essays which gain the prizes; and the other Essays will be returned on the application of the writers.

5. That the Society is not bound to give an award, unless they consider one of the Essays worthy of a prize.

6. That, in all reports of experiments, the expenses shall be accurately detailed: that only the Imperial weights and measures are those by which calculations are to be made: that prizes may be taken either in money or plate, at the option of the successful candidates; and that no prize be given for any Essay which has already appeared in print.

NOTICE.

It is requested that all communications, addressed to the Society, of experiments on land—whether of draining, liming, manuring, or other operation—be accompanied with the cost of such operation, with the value of the land to rent previous and subsequent thereto, and an analysis of the soil upon which such experiments have taken place, of a specimen of the soil, to be analysed by persons employed by the Society: also further requested that, in communications relative to experiments on land in foreign countries, the measures be stated in English.

ANNUAL SUBSCRIPTIONS.

The Members of the Society are reminded that their Annual Subscriptions become due *in advance* on the 1st of January each year, and that by the rules of the Society no Journals can be forwarded or delivered to those Members whose Subscriptions are in arrear.

The utmost facility is afforded for the transmission of Subscriptions to the Secretary by means of Post Office orders, a method of payment which is found to be less subject to delay, or mistake in names, than any other that can be recommended for adoption.

Royal Agricultural Society of England.

1842—1843.

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- VAN DE WEYER, M. SYLVIAN, Belgian Minister.

Royal Agricultural Society of England.

ANNIVERSARY MEETING,

12, HANOVER SQUARE, MONDAY, MAY 23, 1842.

REPORT OF THE COUNCIL.

FOUR years only have elapsed since the foundation of the English Agricultural Society, and two only from the date of its incorporation to the present time. In looking back upon the progress of its labours and the steady prosecution of its national objects, it cannot fail to be the source of sincere gratification to its numerous members, and to every well-wisher of his country, that, based on principles of the soundest policy and most evident practical utility, this Society has succeeded in impressing on the agricultural world a just sense of the incalculable results which must attend the rational application of science to agriculture, in increasing the immense capabilities of our native soil, and in developing the hidden resources of the empire. In that short period the Society has laid the firm foundation of its future progress; and although the full accomplishment of its objects can only be the result of a more extended circuit of its labours, the influence of its example and operation has already tended to clear away those local prejudices in farming, which from time immemorial had proved the fatal obstacles to general improvement, and has excited a candid spirit of inquiry on every subject connected with the common good of the country and the individual interests of its members. The good seed has been care-

fully sown, the young plant is up and thriving, and there is every promise of an abundant harvest to be reaped in future years.

The motto of the Society comprises, in the terms of its enunciation, the vital germ of every progressive and stable improvement, not only in agricultural economy, but in every other branch of national industry under the direction and control of the mind; and the union of practice and science constitutes accordingly the perfection of our principles of action in every department of good husbandry, the salutary restraints of the one principle preventing the undue preponderance of the other. The routine of local practice and the limited rules of cultivation unvaryingly adopted and followed in particular districts, have at length been found not only to be imperfect means for the attainment of the end in view, but being confined to their own peculiar case, they have had no general application, because founded on no general principles. While, however, these local prejudices have so long proved obstacles to improvement, and are necessarily the result of the adoption of *practice* only, obsolete in its date, and uncorrected by intelligent principles, the Council are most anxious, at the present moment, to guard their members against the opposite evil of the undue and arbitrary application of mere unaided and theoretical *science* to the operations of agriculture. It is the natural tendency of the human mind to run into extremes, instead of holding the just balance of dispassionate reason in the pursuit of its inquiries. No sooner are men convinced of one error, than their liability to fall into an opposite one becomes apparent; and in the case of agriculture, the prejudices of past ages having given way before the salutary conviction of just principles, it has naturally resulted that the evils of the present day are those attendant on an incorrect or undue appreciation of science itself, or of science falsely so called; practice, in many instances, instead of being enlightened or directed in its operations by the guidance of novel and untried theories, being only found to be disturbed in its course by the adoption of suggestions for its improvement derived from a science hastily assumed to be perfect while its very elementary truths are either distorted or

imperfectly understood. To discover the recondite laws of vegetable life, and to ascertain the effect of chemical influence, as well as of mechanical and physical condition, in promoting, retarding, or modifying their agency, are among the problems of a higher science than we yet possess; and it is the empirical assumption of fallacious principles having the semblance only of truth, which leads to so many false theories and wrong practices, and brings disgrace and injury on the just cause of a sound and discreet application of genuine science. It will be the constant duty of the Council to impress upon every member of the Society their uniform and decided opinion, that experiment must ever form the indispensable basis of scientific truth, and practice the only sure and satisfactory road to agricultural improvement.

At the last general meeting of the Society, the Council announced to the members their intention to apply to her Majesty's Chief Commissioner of Woods and Forests, for a space of ground on which to erect, in London, a complete establishment for the local purposes of the Society in the metropolis, and Lord Duncannon not only placed at the refusal or acceptance of the Council a suitable space of crown land in the neighbourhood of St. Martin's-lane, but Mr. Dean also favoured them with numerous plans for the construction of the edifice. These proposals received the deliberate consideration of the House Committee, to whom they were referred, and the Council on receiving their report resolved to abandon that design on the grounds of the almost ruinous outlay of capital required for its accomplishment, and the local advantages only which would be attained by the undertaking; while the general interests of the Society would be injured by the financial embarrassment resulting from its adoption. The Council, therefore, concurred in the recommendation of the House Committee, that a suitable house should be selected for the ordinary purposes of the Society's official business; in which ample accommodation could be obtained for the secretary's office, the meetings of the council and committees, and the general meetings; and in which a library for the reception of works of reference and the most recent English and foreign publications

on agricultural subjects could daily be consulted by the members of the Society. All these advantages, the Council have the satisfaction of stating, have not only been fully attained in the present house in which they now meet, but an opportunity has also presented itself of placing the remainder of the house not required for the purposes of the Society at the disposal of the secretary, as a suitable residence for himself and his family—an arrangement which will not only materially conduce to the satisfactory and convenient discharge of his official duties, but will at the same time be advantageous, in many points of view, to the general interests of the Society; and the whole of these desirable objects accomplished at an annual rent so moderate as to exceed but by 30*l.* the yearly payment for the hire of the apartments formerly occupied in Cavendish Square; the rent of the whole of the present house being 300*l.*, and that of the fixtures 30*l.*, with a liability of 50*l.* for rates and taxes: while the charge on the apartments alone in Cavendish Square amounted to 350*l.*

The Finance Committee have reported the steady funding effected from time to time of the life-compositions of governors and members, and have announced, through the medium of the Journal, the great advantage attending the transmission of subscriptions from the country by means of post-office orders. They have also presented to the Council the several balance-sheets of the accounts of the Society, as examined and approved by the auditors, and now laid on the table for inspection, together with the general ledger of accounts, in which the details of the various receipts and payments will be found entered at length under their proper heads: and the following statement of the present amount of members; no less than 500 new members having been elected during the last six months:—

Life governors	.	.	.	101
Annual governors	.	.	.	211
Life members	.	.	.	328
Annual members	.	.	.	5194
				<hr/>
				5834

The Journal Committee have reported that the whole of the new Part is now printed, and on the point of publication ; and the Council congratulate the members on the valuable matter which the Journal, as their own publication, continues to comprise within its pages.

The Council have the gratification to find that no less than 2000 impressions of Mr. Main's article on Cottage Gardening, printed separately for cheap distribution (at a penny each copy), have been already distributed ; and that Mr. Burke has furnished to the Journal a compilation on ' Cottage Economy and Cookery,' which they intend shall be also reprinted in a similar cheap form for distribution among the cottagers of the kingdom.

The General Bristol Committee have reported the near completion of their arrangements, and the rapid progress already made by Mr. Manning in the erection of the pavilion and show-yard, agreeably with the plans adapted to the occasion, by the favour of Sir Robert Smirke and Mr. Dean. They have also accepted the handsome offer made to them by the Committee of the Victoria Rooms of the free use of the whole of that large and commodious building during the period of the meeting—an offer not only most acceptable in itself, as supplying accommodation so ample for the Council dinner, and for the various purposes in the daily transaction of the business connected with the Council and Finance Committee, but especially desirable from the circumstance of its immediate proximity to the show-yard and to the pavilion erected within its enclosure : and have reported their engagement in the preparation of a complete programme of the meeting, a copy of which will in due time be transmitted by post to each member of the Society.

The Council have decided that the annual country meeting of 1843, for the north-eastern district (comprising the counties of Derby, Leicester, Nottingham, Lincoln, Rutland, and the north division of Northampton), shall be held at the town of Derby ; where, the Council have been informed, a strong desire is already felt to receive the Society in the most honourable manner, and promote to the utmost of their power the success of that meeting.

The interest which has been created throughout the country by the present mode of a division of districts, in one of which the place of the country meeting will be held successively year after year; and the good effects which are likely to result in those districts from the preparation set on foot in anticipation of the meeting, hold out a distinct prospect of the great benefits eventually to be derived from this prescribed arrangement in the progress of the annual meetings throughout the country.

The Council have enacted an important bye-law for regulating the elections at the anniversary meeting, and facilitating the mode by which the members at large of the Society may, with the utmost freedom, have an opportunity of recording their votes on that occasion, in reference to the election of those members of the Society whom they may think fit to elect to fill the vacancies in the Council, annually created by the terms of the charter; and thus be enabled, from year to year, to make choice of such members as, in their opinion, will best discharge the important duties conferred upon them by that election.

The Society is deeply indebted to her Majesty's office of Woods and Forests, in receiving from that department of the government, when under the control of Viscount Duncannon, every attention in the institution, at their desire, of experiments by Mr. Griffith, at the King William's-town Experimental Farm, in Ireland, on the comparative dairy value of Scotch and Irish cows: and to Mr. John Shaw Lefevre, who has communicated to the Council, on the part of the Board of Trade, his intention to transmit to the Society a notice of any important agricultural implements which may, from time to time, be sent to that department of the government from abroad.

The Council have to record their sense of Dr. Daubeny's disinterested liberality in undertaking, at his own expense, a journey into Spain, for the express purpose of ascertaining the circumstances and extent, in the district of Estremadura, of the geological formation, or mineral vein, of *phosphorite*, or native phosphate of lime, a mineral substance, which holds out the prospect of becoming, to a certain extent, and when brought by artificial

means into a proper mechanical state, a substitute for the earthy part of bones.

The Council finally have the pleasure of announcing that they have placed the Agricultural Society of Newfoundland among the number of the corresponding societies ; and have taken advantage of the probable visit to this country of Dr. Liebig, of the University of Giessen, in the Grand Duchy of Hesse Darmstadt ; and of Mr. Henry Colman, commissioner for the agricultural survey of the state of Massachusetts,—the former one of the most distinguished and accomplished chemists of Europe, and the latter one of the best practical writers on agricultural subjects in the United States of America—to enrol their names in the list of honorary members ; from all of whom the Society have already received so much attention, and so many solid advantages.

By order of the Council,

JAMES HUDSON, SECRETARY.

General Meetings of 1842-3.

THE GENERAL DECEMBER MEETING, at the Society's House, No. 12, Hanover Square, London, on Saturday, December 10, 1842, at twelve o'clock precisely.

The ANNIVERSARY MEETING, in London, on Monday, May 22, 1843, at twelve o'clock precisely.

The ANNUAL COUNTRY MEETING, at Derby, the principal day of the Show being Thursday, July 13, 1843.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Statement of Accounts from the 1st of July to the 31st of December, 1841.

RECEIPTS.		EXPENDITURE.	
£.	s. d.	£.	s. d.
Balance in the hands of the Bankers on the 30th of June, 1841	1500 16 10	Permanent Charges	275 0 0
Ditto in the hands of the Secretary on the 30th of June, 1841	24 13 11	Establishment	403 4 11
Dividend on 4700 <i>l.</i> New 3½ per Cent. Annuities	82 5 0	Expenses of Journals	396 1 4
Dividends on 1000 <i>l.</i> 3½ per Cent. Reduced Annuities	35 0 0	Postage and Carriage	60 4 1
Subscriptions received during the Half-Year	2864 18 0	Miscellaneous	54 13 6
		Prize Cheque drawn in preceding Half-year	10 0 0
		Amount of Prizes paid	1310 0 0
		Excess of Expenditure over Receipts at Liverpool	946 3 11
		Cash in the hands of the Bankers on the 31st of Dec., 1841	1028 12 2
		Cash in the hands of the Secretary on the 31st of Dec., 1841	23 13 10
			£4507 13 9

C. B. CHALLONER,

Chairman of the Finance Committee.

THOMAS RAYMOND BARKER.

THOMAS AUSTEN.

HENRY BLANSHARD.

C. H. TURNER,
THOMAS KNIGHT,

} Auditors on the part
of the Society.

Meeting at Bristol.

PRINCIPAL DAY OF THE SHOW, JULY 14, 1842.

AWARD OF PRIZES.

CATTLE: I. *Short Horns.*

JOHN PARKINSON, of Ley Fields, near Newark, and JOHN BOOTH, of Cotham, near Newark, Nottinghamshire: the Prize of THIRTY SOVEREIGNS, for their 5 years and 3 months-old Short-horned Bull; bred by Jonas Whitaker, of Burley, near Otley, Yorkshire.

THOMAS FORREST, of Stretton, Cheshire, near Warrington: the Prize of FIFTEEN SOVEREIGNS, for his 3 years and 4 months-old Improved Short-horned Bull; bred by himself.

The REV. CHARLES MORDAUNT, of Badgworth Rectory, near Cross, Somersetshire: the Prize of TWENTY SOVEREIGNS, for his 2 years and 2½ months-old Short-horned Bull; bred by Colonel Cradock.

JOHN BOOTH, of Killerby, near Catterick, Yorkshire: the Prize of FIFTEEN SOVEREIGNS, for his 5 years and 5 months-old Short-horned Cow; bred by himself.

JOHN FORREST, of Stretton, Cheshire, near Warrington: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 2 months-old Improved Short-horned in-calf Heifer; bred by himself.

R. M. JAUQUES, of Silton Hall, near Northallerton, Yorkshire: the Prize of TEN SOVEREIGNS, for his 1 year and 9 months-old Short-horned Yearling Heifer; bred by himself.

CATTLE: II. *Herefords.*

JOHN YEOMANS, of Moreton-on-Lugg, near Hereford: the Prize of THIRTY SOVEREIGNS, for his 3 years and 1 month-old Hereford Bull; bred by himself.

JOHN PRICE, of Poole House, near Upton-on-Severn, Worcestershire: the Prize of FIFTEEN SOVEREIGNS, for his 8 years and 3 months-old Hereford Bull; bred by himself.

JOHN PRICE, of Poole House, near Upton-on-Severn, Worcestershire: the Prize of TWENTY SOVEREIGNS, for his 1 year, 2 weeks, and 3 days-old Hereford Bull; bred by himself.

JOHN YEOMANS, of Moreton-on-Lugg, near Hereford: the Prize of FIFTEEN SOVEREIGNS, for his 8 years and 6 months-old Hereford Cow; bred by John Turner of Noke, near Leominster, from the stock of Richard Yeomans, of Howton Court.

The Rev. JOHN ROBERT SMYTHIES, of Lynch Court, near Leominster: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 5 months-old Hereford in-calf Heifer; bred by himself.

JOHN WALKER, of Burton, near Worcester: the Prize of TEN SOVEREIGNS, for his 1 year and 5½ months-old Hereford Yearling Heifer; bred by himself.

CATTLE: III. *Devons.*

JAMES S. BULT, of Kingston, and JAMES BOND, of Heathfield, near Taunton, Somersetshire: the Prize of THIRTY SOVEREIGNS, for their 5 years and 3 months-old Devon Bull; bred by John Quartly, of Molland, near South Molton, Devonshire.

CHARLES HENRY WEBBER, of Buckland-Chellows, near Barnstaple, Devonshire: the Prize of FIFTEEN SOVEREIGNS, for his 3 years and 2 months-old North-Devon Bull; bred by Mr. Quartly, of Molland.

THOMAS STEPHENS, of Atherstone, near Ilminster, Devonshire: the Prize of TWENTY SOVEREIGNS, for his 1 year and 7 months-old Devon Bull; bred by himself.

JOHN QUARTLY, of Molland, near South Molton, Devonshire: the Prize of FIFTEEN SOVEREIGNS, for his 7 years and 2 months-old Devon Cow; bred by Francis Quartly, of Molland.

JOHN QUARTLY, of Molland, near South Molton, Devonshire: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 5 months-old Devon in-calf Heifer; bred by himself.

JAMES DAVY, of North Molton, near South Molton, Devonshire: the Prize of TEN SOVEREIGNS, for his 1 year and 2 months-old Devon Yearling Heifer; bred by himself.

CATTLE: IV. *Any Breed or Cross.*

THOMAS CHILD, of Arlington, near Hailsham, Sussex: the Prize of THIRTY SOVEREIGNS, for his 4 years and 5 months-old Sussex Bull; bred by himself.

RICHARD P. RICH, of Chippenham, Wiltshire: the Prize of FIFTEEN SOVEREIGNS, for his 4 years and 4 months-old Mixed or Cross-bred Bull; bred by Joseph Bodman, of Calne.

The Hon. M. W. BELLEW NUGENT, of Higham Grange, near Hinckley, Leicestershire : the Prize of TWENTY SOVEREIGNS, for his 2 years 3 months and 11 days-old Long-horned Bull ; bred by Mr. Hortin, of Sherbourne, Warwickshire.

RICHARD P. RICH, of Chippenham, Wiltshire : the Prize of FIFTEEN SOVEREIGNS, for his 6 years and 7 months-old Mixed or Cross-bred Cow ; bred by himself.

THOMAS JOSEPH PENSAM, of Leigh, near Tewkesbury, Gloucestershire : the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 4 months-old pure Long-horned in-calf Heifer ; bred by himself.

The Hon. M. W. BELLEW NUGENT, of Higham Grange, near Hinckley, Leicestershire : the Prize of TEN SOVEREIGNS, for his 1 year and 3 months-old Pure-Leicester or Long-horned Yearling Heifer ; bred by himself.

EDWARD BRADLEY, of Treguff Place, near Cowbridge, Glamorganshire : Sir Charles Morgan's Prize of TEN SOVEREIGNS, for his Pair of Glamorgan Heifers, 2 years and 4 months old ; and bred by himself.

EDWARD BRADLEY, of Treguff Place, near Cowbridge, Glamorganshire : Sir Charles Morgan's Prize of FIVE SOVEREIGNS, for his second Pair of Glamorgan Heifers, 2 years and 4 months old ; and also bred by himself.

HORSES.

JOSEPH NEELD, M.P., of Grittleton, near Chippenham, Wiltshire : the Prize of THIRTY SOVEREIGNS, for his 5 years-old Cart Stallion.

HENRY HEATH and JOSEPH C. GADD, of Weare, near Axbridge, Somersetshire : the Prize of TWENTY SOVEREIGNS, for their 7 years-old Cart Stallion ; bred by John Bilby, of Rodney Stoke, near Wells, Somersetshire.

RICHARD DAINTREE, of Hemingsford Abbots, near St. Ives, Huntingdonshire : the Prize of FIFTEEN SOVEREIGNS, for his 2 years-old Cart Stallion ; bred by himself.

GEORGE THOMAS, of Shirehampton, near Bristol : the Prize of TWENTY SOVEREIGNS, for his Cart Mare and Foal ; bred by himself. The Sire of the Foal was the property of William Price, of Almondsbury, Gloucestershire.

The DUKE of MARLBOROUGH, of Blenheim Place, near Woodstock, Oxfordshire : the Prize of TEN SOVEREIGNS, for his Cart Mare and Foal ; the Mare having been bred by the late Arthur Annesley, of Bletchington, Oxon.

RICHARD DAINTREE, of Hemingsford Abbots, near St. Ives, Huntingdonshire : the Prize of TEN SOVEREIGNS, for his 2 years-old Filly for agricultural purposes ; bred by himself.

HILLYER REEVE, of Wroughton, near Swindon, Wiltshire: the Prize of THIRTY SOVEREIGNS, for his 15 years-old Stallion; bred by the Duke of Cleveland, in Yorkshire.

SHEEP: I. *Leicesters.*

JOSEPH BENNETT, of Tempsford, Bedfordshire, near St. Neots, Huntingdonshire: the Prize of THIRTY SOVEREIGNS, for his 16 months-old Shearling Leicester Ram; bred by himself.

SAMUEL BENNETT, of Bickerings Park, near Woburn, Bedfordshire: the Prize of FIFTEEN SOVEREIGNS, for his 16 months-old Shearling Pure New Leicester Ram; bred by himself.

SAMUEL BENNETT, of Bickerings Park, near Woburn, Bedfordshire: the Prize of THIRTY SOVEREIGNS, for his 40 months-old Pure Leicester Ram; bred by himself.

JOSEPH BENNETT, of Tempsford, Bedfordshire, near St. Neots, Huntingdonshire: the Prize of FIFTEEN SOVEREIGNS, for his 32 months-old Leicester Ram; bred by himself.

[The Judges withheld the award of Prizes from the Shearling Ewes, on account of the want of merit in the Sheep exhibited for those Prizes.]

SHEEP: II. *Southdowns, &c.*

STEPHEN GRANTHAM, of Stoneham, near Lewes, Sussex: the Prize of THIRTY SOVEREIGNS, for his 15 months-old Shearling Southdown Ram; bred by himself.

JONAS WEBB, of Babraham, near Cambridge: the Prize of FIFTEEN SOVEREIGNS, for his 16 months-old Shearling Southdown Ram; bred by himself.

JONAS WEBB, of Babraham, near Cambridge: the Prize of THIRTY SOVEREIGNS, for his 64 months-old Southdown Ram; bred by himself.

JOHN HARRIS, of Hinton, near Abingdon, Berkshire: the Prize of FIFTEEN SOVEREIGNS, for his 28 months-old Pure Southdown Ram; bred by himself.

SAMUEL WEBB, of Babraham, near Cambridge: the Prize of TEN SOVEREIGNS, for his Pen of 5 Shearling Southdown Ewes, 16 months old; and bred by himself.

JAMES BEAVEN, jun., of Thornham, near Devizes, Wiltshire: the Prize of FIVE SOVEREIGNS, for his Pen of 5 Shearling Southdown Ewes, 17 months old; and bred by himself.

SHEEP: III. *Long-Wools* (not qualified as Leicesters).

CHARLES LARGE, of Broadwell, near Burford, Oxfordshire: the Prize of THIRTY SOVEREIGNS, for his 16 months-old New Oxfordshire Long-woolled Shearling Ram; bred by himself.

CHARLES LARGE, of Broadwell, near Burford, Oxfordshire : the Prize of FIFTEEN SOVEREIGNS, for his 16 months-old New Oxfordshire Long-woolled Shearling Ram ; bred by himself.

THOMAS WELLS, of Hampnett, near Northleach, Gloucestershire : the Prize of THIRTY SOVEREIGNS, for his 40 months-old Improved Cotswold Ram ; bred by himself.

CHARLES LARGE, of Broadwell, near Burford, Oxfordshire : the Prize of FIFTEEN SOVEREIGNS, for his 28 months-old New Oxfordshire Long-woolled Ram ; bred by himself.

EDWARD SMITH, of Charlbury, Oxfordshire : the Prize of TEN SOVEREIGNS, for his Pen of 5 Shearling Long-woolled Oxfordshire Ewes, 15½ months old ; and bred by himself.

CHARLES LARGE, of Broadwell, near Burford, Oxfordshire : the Prize of FIVE SOVEREIGNS, for his Pen of 5 Shearling Long-woolled Ewes, 16 months old ; and bred by himself.

PIGS.

JOSEPH THOMLINSON, of Laverock Bank, near Liverpool : the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 6 months-old Leicester Boar ; bred by Thomas Crofton, of Holywell, near Durham.

EDWARD G. BARNARD, M.P., of Gosfield Hall, Halstead, Essex : the Prize of FIVE SOVEREIGNS, for his 2 years and 2 months-old Improved Essex Boar ; bred by himself.

JOSEPH THOMLINSON, of Laverock Bank, near Liverpool : the Prize of TEN SOVEREIGNS, for his 2 years and 9 months-old Sow ; bred by William Donald, of Solway House, Cumberland.

EDWARD G. BARNARD, M.P., of Gosfield Hall, Halstead, Essex : the Prize of TEN SOVEREIGNS, for his 3 Improved Essex Sow Pigs, 8 months old ; and bred by himself.

EXTRA STOCK.

JOHN YEOMANS, of Moreton-on-Lugg, near Hereford : the sum of FIVE SOVEREIGNS, for his 1 year and 6 months-old Hereford Yearling Heifer ; bred by himself.

THOMAS MILLER, of Castle Farm, Sherborne, Dorsetshire : the sum of TWO SOVEREIGNS, for his 5 months-old Calf ; bred by himself.

WILLIAM ELLISON, of Sizergh Castle, near Kendal, Westmoreland : the sum of ONE SOVEREIGN, for his 23 weeks and 5 days-old Sizergh Boar ; bred by himself.

WILLIAM ELLISON, of Sizergh Castle, near Kendal : the sum of ONE SOVEREIGN, for his 23 weeks and 5 days-old Sizergh Sow ; bred by himself.

Commendations.

WILLIAM WOODWARD, of Bredon's Norton, near Tewkesbury, Gloucestershire : a 4 years and 5 weeks-old pure Short-horned Fat Ox ; bred and fed by himself.

HENRY BROWN, of Stawell, near Bridgewater, Somersetshire : a 5 years and 5 months-old Devon Ox ; bred by Richard Hodge, of Goathurst, near Bridgewater.

*ROBERT BEMAN, of Dinnington, near Stow-on-the-Wold, Gloucestershire : a 40 months-old Cotswold Wether ; bred by himself.

RICHARD EMERY, of Storrington, near Petworth, Sussex : a 2 years and 5 months-old Sussex Bull ; bred by Thomas Childs, of Michelham, Sussex.

*JOHN and RICHARD LAMBE, of Wilmington, near Lewes, Sussex : a 7 years and 5 months-old Sussex Cow ; bred by themselves.

JONAS WEBB, of Babraham, near Cambridge : a 16 months-old Southdown Shearling Ram ; bred by himself.

JONAS WEBB, of Babraham, near Cambridge : a second 16 months-old Southdown Ram ; bred by himself.

*EDWARD SMITH, of Charlbury, near Eustone, Oxon. : a 39½ months-old Long-woolled Oxfordshire Ram ; bred by himself.

GEORGE WEBB HALL, of Sneed Park, near Bristol : a 9 months-old Wild-Boar-cross Boar ; bred by himself.

PHILIP PUSEY, M.P., of Pusey, near Faringdon, Berkshire : a 1 year and 9 months-old Berkshire Boar ; bred by John Harris, of Hinton.

PHILIP PUSEY, M.P., of Pusey, near Faringdon, Berkshire : a 1 year and 8 months-old Improved Essex Boar ; bred by W. Fisher Hobbs, of Mark's Hall.

RICHARD P. RICH, of Chippenham, Wiltshire : a 20 weeks-old Berkshire Boar ; bred by himself.

Captain LEWIS SHEDDEN, of Bittern Manor House, near Southampton : a 9 months-old Surrey and Berkshire (with one cross of Sussex) Boar.

The Rev. JAMES C. BROWNE, of Compton-Martin, and Nempnett, near Bristol : a 1 year and 11 months-old Improved Neapolitan Boar ; bred by himself.

EDWARD BOWLY, of Siddington House, near Cirencester, Gloucestershire : a 1 year and 4 months-old Berkshire Boar ; bred by himself.

JOHN GUNDRY, of Clatford Farm, near Marlborough, Wiltshire : an 8½ months-old Berkshire Boar ; bred by himself.

WILLIAM ELLISON, of Sizergh Castle, near Kendal, Westmoreland : a 1 year and 10½ months-old Sizergh Boar ; bred by himself.

✓ CHARLES RANDELL, of Chadbury, near Evesham, Worcestershire : a 2 years and 4 months-old Chinese Boar ; bred by Edward Greaves, of Barford, near Warwick.

THOMAS M. GOODLAKE, of Wadley House, near Faringdon, Berkshire : a 1 year and 3 days-old Wadley Boar ; bred by himself.

WILLIAM PEARCE, of Langley, near Chippenham, Wiltshire : two 7 months and 2 weeks-old Wilts and Berks Boars ; bred by himself.

JOHN HARRIS, of Hinton, near Abingdon, Berkshire : two 28 weeks and 4 days-old Berkshire Boars ; bred by himself.

The Right Hon. CHARLES SHAW LEFEVRE, M.P., of Heckfield, near Hartfordbridge, Hampshire : a 1 year and 2½ months-old Boar of the three-quarters Heckfield and slight-cross of Berks breed ; bred by himself.

JOHN CANNICOTT, of Stibbear Farm, near Ilminster, Somersetshire : a 10 months-old Berkshire Boar ; bred by himself.

GEORGE ASHE GODDARD, of Cliffe Pypard, near Wootton-Bassett, Wiltshire : a 1 year and 1 month-old Improved Essex Boar ; bred by himself.

WILLIAM FISHER HOBBS, of Mark's Hall, near Coggeshall, Essex : a 37 months-old Improved Essex Boar ; bred by himself.

JAMES PERMEWAN, of Tresidder, near Penzance, Cornwall: a 4 years-old Essex Boar; bred by Lord Western.

The Rev. JOHN VANE, of Wrington, near Bristol: a 51 weeks and 1 day-old Boar of his own breed; bred by himself.

THOMAS IRESON MORRISH, of North Cadbury, near Wincanton, Somersetshire: an 8 months-old China and Berks Boar; bred by himself.

[Those marked (*) were "HIGHLY COMMENDED," all the others "COMMENDED."]

SELECTION OF SEED-WHEAT.

WILLIAM HENRY PRICKMAN'S *Old Lammas White Wheat*.

WILLIAM WOODWARD'S *Creeping Red Wheat*.

JAMES DAVIS'S *Glory of the West Red Wheat*.

[The result of the cultivation of these Wheats, and the comparison of their productiveness with that of other varieties commonly grown in the respective neighbourhoods where the trials are made, will be reported to the General December Meeting in 1843.]

CHEESE.

JOHN TALBOTT, of Baltonsborough, near Glastonbury, Somersetshire: the Prize of TEN SOVEREIGNS, for his sample of White Somerset Cheese.

EDWARD CHURCHIS, of Biddisham, near Axbridge, Somersetshire: the Prize of FIVE SOVEREIGNS, for his sample of Somerset Cheese.

COMMENDATION.—The Judges highly commended the sample of Cheddar Cheese exhibited by J. B. MULLINS, of Wyke-Champflower, near Bruton, Somersetshire.

COTTAGE ECONOMY.—Mr. Main's article on Cottage Gardening, and Mr. Burke's compilation on Cottage Economy and Cookery, have each been reprinted from the Journal in a separate form, for cheap distribution. Either or both of these tracts may be obtained by members at the rate of 1s. per dozen copies, on their enclosing to the Secretary a post-office money-order for the number required; at the same time stating the most eligible mode of conveyance by which the copies can be transmitted to their address.

VOLUMES OF THE JOURNAL.—The first Volume of the Journal consists of *four* parts, the second and third Volumes of *three* parts each (the second and third parts of the third Volume being comprised in a double number)

Meeting at Derby.

PRINCIPAL DAY OF THE SHOW: THURSDAY, JULY 13, 1843.

THE PRIZES ARE OPEN TO GENERAL COMPETITION.

FORMS OF CERTIFICATES TO BE PROCURED ON APPLICATION TO THE SECRETARY, 12, HANOVER SQUARE, LONDON. ALL CERTIFICATES MUST BE RETURNED, FILLED UP, TO THE SECRETARY, ON OR BEFORE THE 1ST OF JUNE, 1843.

Prizes for Improving the Breed of Cattle.—1843.

SHORT-HORNS.

CLASS

1. To the owner of the best Bull calved previously to the 1st of January, 1841 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1841, and more than one year old Twenty Sovereigns.
3. To the owner of the best Cow in milk Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer Ten Sovereigns.

HEREFORDS.

1. To the owner of the best Bull calved previously to the 1st of January, 1841 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1841, and more than one year old Twenty Sovereigns.
3. To the owner of the best Cow in milk Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer Ten Sovereigns.

DEVONS.

1. To the owner of the best Bull calved previously to the 1st of January, 1841 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1841, and more than one year old Twenty Sovereigns.

CLASS

3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . . Ten Sovereigns.

CATTLE OF ANY BREED, OR CROSS:

Not qualified to compete as Short-horns, Herefords, or Devons.

1. To the owner of the best Bull calved previously to the 1st of January, 1841 . . . Thirty Sovereigns.
To the owner of the second-best ditto ditto . . . Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1841, and more than one year old . . . Twenty Sovereigns.
3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . . Ten Sovereigns.

HORSES.

1. To the owner of the best Cart-Stallion of 4 years old and upwards . . . Thirty Sovereigns.
To the owner of the second-best ditto ditto . . . Twenty Sovereigns.
2. To the owner of the best two years-old ditto foaled since the 1st of January, 1841 . . . Fifteen Sovereigns.
3. To the owner of the best Cart-Mare and Foal . . . Twenty Sovereigns.
To the owner of the second-best ditto . . . Ten Sovereigns.
4. To the owner of the best two years-old Filly . . . Ten Sovereigns.
5. To the owner of the best THOROUGH-BRED STALLION, which shall have served Mares at a price not exceeding three guineas (and with a groom's fee of not more than five shillings), in the season of 1843 . . . Thirty Sovereigns.

S H E E P.

Prizes for Improving the Breed of Sheep.—1843.

LEICESTERS.

CLASS

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling Ewes . . . Ten Sovereigns.
To the owner of the second-best ditto ditto . . . Five Sovereigns.

SOUTH DOWNS, OR OTHER SHORT-WOOLLED SHEEP.

CLASS

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling
Ewes Ten Sovereigns.
To the owner of the second-best ditto ditto . . . Five Sovereigns.

LONG-WOOLLED SHEEP :

Not qualified to compete as Leicesters.

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling
Ewes Ten Sovereigns.
To the owner of the second-best ditto ditto . . . Five Sovereigns.

PIGS.

1. To the owner of the best Boar of a large breed . Ten Sovereigns.
To the owner of the second-best ditto ditto . . . Five Sovereigns.
2. To the owner of the best Boar of a small breed . Ten Sovereigns.
To the owner of the second-best ditto ditto . . . Five Sovereigns.
3. To the owner of the best breeding Sow of a large
breed Ten Sovereigns.
4. To the owner of the best breeding Sow of a small
breed Ten Sovereigns.
5. To the owner of the best pen of three breeding
Sow-Pigs of the same litter, above four and
under nine months old Ten Sovereigns.

IMPLEMENTS.

A sum not exceeding Three Hundred Sovereigns.

CHEESE.

- To the Exhibitor of the best Hundred-weight of
Cheese (of any kind) Ten Sovereigns.
- To the Exhibitor of the second-best ditto (of any
kind) Five Sovereigns.

EXTRA STOCK, ROOTS, AND SEEDS.

For Extra Stock of any kind, not shown for any of the above Prizes, and for Roots, Seeds, &c., Prizes may be awarded and apportioned, by the Committee and Judges, to an amount not exceeding in the whole Fifty Sovereigns.

ANY NEW IMPLEMENT.

For the Invention of any new Agricultural Implement, such sum as the Society may think proper to award.

SEED-WHEAT.

I. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor, at the Meeting at Derby, of the best 14 bushels of White Wheat, of the harvest of 1842, and grown by himself.

II. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor, at the Meeting at Derby, of the best 14 bushels of Red Wheat, of the harvest of 1842, and grown by himself.

III. Twenty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor, at the Meeting at Derby, of the best 14 bushels of Spring Wheat, of the harvest of 1842, and grown by himself.

Competitors are requested to send with their wheat, specimens, fairly taken, of the same in the ear, with the whole of the straw, in a bundle not less than one foot in diameter, and with the roots attached.

[12 bushels of the wheat will be sealed up by the judges, and one of the remaining bushels of each variety will be exhibited as a sample to the public; the other being kept for comparison with the produce of the next year. At the General Meeting in December, 1844, the prizes will be awarded.]

The two best samples of each of these three classes of wheat, without at that time distinguishing, in any of the cases, between the comparative merits of either sample, will be selected by the judges appointed for the Meeting at Derby; and will be sown, under the direction of the Society (the winter wheats in the autumn of 1843, and the spring wheat not earlier than the 1st of March, in 1844) by four farmers; who will make their report, upon which the prizes will be awarded, provided there be sufficient merit in any of the samples. Ten Sovereigns will be given at the Meeting at Derby to each Exhibitor whose Wheat has been selected for trial.

* * No variety of Wheat which has been selected for trial at any previous show shall be qualified to compete.

ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

Prizes for 1843.

PRIZE ESSAYS.

1. ARTIFICIAL FOOD FOR CATTLE OR SHEEP.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best trial of the relative value of different sorts of Artificial Food for Cattle or Sheep.

Competitors will be required to attend to the following conditions in their prosecution of experiments on this subject :—

1. One or more head of cattle or sheep to be put to each of the sorts of artificial food selected for trial.
2. To ascertain by measurement or weighing the state of the animals when first put to feed, and at given intervals afterwards.
3. When the increase has been ascertained at the end of one or two months, the experiment to be reversed, and the animals put to the sort of food which in the first month was consumed by their competitors, and the increase ascertained in a manner similar to that applied in the first month.
4. In all cases, the quantity of food consumed by each class of cattle or sheep to be accurately stated.

2. NATURAL FOOD FOR CATTLE OR SHEEP.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best trial of the relative value of different sorts of Natural Food for Cattle or Sheep.

Competitors will be required to attend to the same conditions in reference to this prize as in the preceding.

3. HORSE AND OX TEAMS.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Comparative Advantages in the Employment of Horses and Oxen in Farming Work.

Competitors will be required to attend to the following conditions :—

1. The age and breed of both horses and oxen, with the time at which they were first put to work, must be accurately stated.
2. Both horses and oxen to be in good working condition, and regularly employed on the same farm (stating the nature of the soil) during a whole year.
3. The amount of work, whether on road or field, of each pair of horses and oxen ; together with remarks upon the manner in which that work has been performed ; and its separate value.
4. The cost of maintenance and farriery of each pair of horses and oxen ; including the separate charge for management.

5. The cost, or presumed value, of each pair of horses and oxen, with their gear, when put to work ; and their value at the close of the comparison.
6. The comparative number of oxen or horses which are required to do the same work.

4. ON THE CONSTRUCTION OF COTTAGES.

The Gold Medal, and Mr. Slaney's addition of Ten Sovereigns to the prize, will be given for the best Treatise on the Form and Construction of Agricultural or other Cottages, with the Outbuildings and Conveniences belonging to them ; together with suggestions for the best methods of constructing Chimneys, Fireplaces, Ovens, Floors, Roofs, and whatever may conduce to the health and comfort of the occupiers ; to comprise Plans, Elevations, and Estimates, in which due regard is to be paid to reasonable economy.

5. ON THE DRAINAGE OF LAND.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best Mode of Under-draining Land, regard being had to variety of Soil, Subsoil, and other local circumstances.

Competitors for this prize will be required to give information on the following subjects of inquiry :—

1. Depth and frequency of drains.
2. Materials,—tiles, stone, or peat.
3. Filling in, whether with tenacious or porous earth.
4. Expense of the various methods.
5. Disposition of drains.
6. Fall required.
7. Direction of drains on land having a considerable slope.
8. Benefit in increasing crop, admitting new modes of culture and stocking, advancing the time of harvest, reducing the amount of horse-labour required on heavy clays, improving climate, &c.
9. Durability of drains.
10. Past and present practice of draining in England.
11. Districts of England which require the most extensive efforts in under-draining.

6. ON LIQUID MANURE.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Account of Results obtained in the application of Liquid Manures, as artificially obtained by composition, or as occurring in their ordinary and natural state.

Competitors will be required to attend to the following points, in the case of each of these classes of liquid manure :—

Artificial Liquid Manure.

1. The nature of the substances either dissolved or suspended in liquid manures *artificially* composed.
2. The soils to which they are best adapted ; and whether to pasture or arable land.
3. The quantity, mode, and season of their application.

Natural Liquid Manure.

1. The nature of those *naturally* combined ; as the urine of cattle and of man, the drainings of stables and farm-yards, &c.
2. Their mode of treatment and preservation.
3. Their application both to pasture and arable land ; the soils and crops to which they are best adapted ; their chemical properties ; and the probable causes of their success or failure ; together with observations on the quantity to be employed on clays and turnip-lands.

7. MANAGEMENT OF FARM-YARD MANURE.

Fifteen Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Mode of Management and Application of Farm-yard Manure.

Competitors will be required to state—

1. The season when made.
2. The materials of which it is composed.
3. The crops for which it is intended.
4. The period of the year when applied.
5. The mode of applying it.

8. ON ARTIFICIAL MANURES, OR HAND-TILLAGES.

Fifteen Sovereigns, or a Piece of Plate of that value, will be given for the best Account of Artificial Mineral and Vegetable Manures, and of the simplest and most effective mode by which their adulteration with spurious substances may be at once detected.

The following information will be required in the case of each of these classes of artificial manure :—

Mineral Manures.

1. The different *inorganic* or mineral substances which have been recommended and used as portable manures ; distinguishing the simple from the compound.
2. The quantities applied per acre ; mode and time of application, whether to grass or arable land ; and nature of the soil.
3. The probable causes of their success or failure.

Vegetable or Animal Manures.

1. The different *organic* and *composite* manures, whether artificially or naturally combined ; and their chemical constitution.
2. The quantity used per acre ; the time and mode of their application, and whether to pasture or arable land.
3. The soils to which the several kinds are best adapted, and the probable causes of the more certain and constant effect produced by them than of the *inorganic* kinds : as also, the causes to which their occasional failure may be attributed.

9. WATER-MEADOWS AND UPLAND PASTURES.—1844.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Comparative Value of Water-meadows and Uplands generally for Cattle, Sheep, and Horses, but especially for Milch Cows.

Competitors will be required to state the following particulars in reference to the trials instituted for the purpose of obtaining practical results on this subject:—

1. The nature of the soil and its state of drainage to be described; and equal portions of upland and water meadow to be selected.
2. Equal numbers of cows of the same age and breed (not less than four in number) to be separately fed in pairs, on each different kind of grass, and to be changed once from one kind of grass to the other; and the quantity, as well as the quality, of the milk from such cows to be ascertained by the lactometer.
3. If made into hay, the quantity of each sort produced on the land, and the quantity, as well as quality, of the milk which has been produced, to be ascertained in a similar manner.
4. The value of spring food and grass, whether in rowen or pasture.
5. The same conditions to be applicable to the feeding of sheep-stock; stating the numbers which the same quantity of each land have separately maintained during a certain period; and whether or not subject to the rot by the flooding.
6. In regard to irrigating the land: the primary cost, whether of catch-water or flow-meadow, of its formation, and the annual expense of management, including the repair of sluices; together with the former and present rent or value.

[Competitors are also requested to state, as far as their observation may have extended, the comparative value of the grasses of water-meadows and uplands, when cut into hay, and consumed as fodder.]

10. PRODUCTION OF FAT AND MUSCLE.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Explanation of the Causes which appear to determine the Production of Fat and Muscle respectively, according to the present state of our knowledge of Animal Physiology.

Competitors will be required to point out—

1. The connection between certain recognised signs of early maturity, as smallness of bone, shape of the ears, mellowness of skin, &c., with the determination of the animal frame to produce fat or muscle.
2. The tendency of certain articles of food to fatten stock, and the adaptation of others to maintain the general frame in a growing state.
3. The disposition of certain breeds to secrete fat externally, and of others internally.
4. The mode in which beans and acorns occasion hardness of flesh in the animals fed on them.

These Essays, except No. 9, must be sent to the Secretary, at 12, Hanover Square, on or before March 1st, 1843.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. That all information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books, or other sources.

2. That drawings, specimens, or models, shall accompany writings requiring them.

3. That all competitors shall transmit a sealed note, containing their names and addresses, with a motto on it to correspond with the one inscribed on the Essay.

4. That the Society shall have the power to publish the whole or any part of the Essays which gain the prizes; and the other Essays will be returned on the application of the writers.

5. That the Society is not bound to give an award, unless they consider one of the Essays worthy of a prize.

6. That, in all reports of experiments, the expenses shall be accurately detailed: that only the Imperial weights and measures are those by which calculations are to be made: that prizes may be taken either in money or plate, at the option of the successful candidates; and that no prize be given for any Essay which has already appeared in print.

NOTICE.

It is requested that all communications, addressed to the Society, of experiments on land—whether of draining, liming, manuring, or other operation—be accompanied with the cost of such operation, with the value of the land to rent previous and subsequent thereto, and an analysis of the soil upon which such experiments have taken place; or a specimen of the soil, to be analysed by persons employed by the Society: also further requested that, in communications relative to experiments on land in foreign countries, the measures be stated in English values.

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